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Escola Tècnica Superior d'Enginyers de Camins, Canals i Ports de Barcelona
UNIVERSITAT POLITÈCNICA DE CATALUNYA

PhD Thesis

IMPACT OF RAIL INFRASTRUCTURE CHARGING SYSTEMS IMPLEMENTED IN EUROPE ON THE COMPETITIVENESS OF HIGH SPEED SERVICES

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CAPÍTULO V – Enseñanzas de Doctorado

Artículo 22. Mención europea en el título de Doctor

1. Se podrá incluir en el anverso del título de Doctor o Doctora la mención "Doctor europeo", siempre que concurran las siguientes circunstancias:

    a) Que, durante el periodo de formación necesario para la obtención del título de doctor, el doctorando haya realizado una estancia mínima de tres meses fuera de España en una institución de enseñanza superior o centro de investigación de un estado miembro de la Unión Europea, cursando estudios o realizando trabajos de investigación que le hayan sido reconocidos por la universidad.

    b) Que parte de la tesis doctoral, al menos el resumen y las conclusiones, se haya redactado y sea presentado en una de las lenguas oficiales de la Unión Europea distinta a cualquiera de las lenguas oficiales en España.

    c) Que la tesis haya sido informada por un mínimo de dos expertos pertenecientes a alguna institución de educación superior o instituto de investigación de un Estado miembro de la Unión Europea distinto de España.

    d) Que, al menos, un experto perteneciente a alguna institución de educación superior o centro de investigación de un Estado miembro de la Unión Europea distinto de España, con el título de doctor, y distinto del responsable de la estancia mencionada en el apartado a) y los mencionados en el apartado c), haya formado parte del tribunal evaluador de la tesis.

2. La defensa de la tesis ha de ser efectuada en la propia Universidad en la que el doctorando estuviera inscrito.

To my parents

ABSTRACT

European railways have been immersed since the nineties in a restructuring process aimed at improving the effectiveness, quality and economic efficiency of the provision of railway services, as well as stimulating the growth of railway markets. This reform has involved a separation between infrastructure management and operation and the introduction of rail infrastructure charges to regulate the use, by railway undertakings, of the infrastructure managed by infrastructure managers.

Rail infrastructure charges aim, in essence, at recovering costs. Nevertheless, they can have an influence on the usage of the infrastructure, especially in corridors where competition between modes exists. Therefore, special attention should be paid to their definition and amount to ensure that they do not counteract the important effort that the European Union is making to help finance and build a European high speed network aimed at strengthening railways and redressing modal share imbalances.

In Europe, legislation requires transparent and non discriminatory rail access charges, based on the principles of short run marginal social cost although mark ups are permitted where necessary to meet financial requirements. However, it does not specify how these principles should be implemented.

This dissertation has three main tasks. Firstly, it calculates the amount of rail infrastructure charge for European high speed lines/services based on the marginal cost. Secondly, it characterises the rail infrastructure charging systems applied to European high speed lines/services, in order to detect if mark ups above the marginal cost of wear and tear are being applied to those services and if so, how they are applied. Finally, it quantifies the impacts on traffic volumes and mode split resulting from bringing the current levels of rail infrastructure charges (applied in the European high speed network) to the level of marginal cost of maintenance and renewals and to the optimal Ramsey mark up.

According to the results obtained, current levels of rail infrastructure charges implemented in Europe have a negative impact on the competitiveness of the high speed passenger services that run on the European railway network, particularly in the cases where the rail market share is currently low (below 80-85%). Thus, mark ups would not have been imposed after careful consideration of their consequences on the market position of railway undertakings in the market segment in question.

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Last but not least, my most sincere gratitude to all my family (parents, brother, grandparents, uncles, aunts and cousins), with a special thought for my grandmother Carmen, and a special thanks to my parents: without their love, infinite patience, support and advice, this dissertation would have never been finished up.

Barcelona, 20 January 2009

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INTRODUCTION

I. MOTIVATIONS

Since the nineties, European railways are immersed in a restructuring process aimed at improving the effectiveness, quality and economic efficiency of the provision of railway services, as well as stimulating the growth of railway markets. This growth of railway markets should alleviate congestion in roads and in air space, as well as promote sustainable development[1], by facilitating a shift from road and airways towards more environmental friendly modes of transport such as rail transport.

The aforementioned reform has involved a separation between infrastructure management and operation and the introduction of rail infrastructure charges to regulate the use, by railway undertakings, of the infrastructure managed by infrastructure managers.

Rail infrastructure charges are aimed, in essence, at recovering costs. Nevertheless, they can have an influence on the usage of the infrastructure, especially in corridors where competition between modes exists. Therefore, special attention should be paid on their amount and definition.

In Europe, legislation requires transparent and non discriminatory rail access charges, based on the principles of short run marginal social cost but with mark ups permitted where necessary to satisfy financial requirements. However, it does not specify how these principles should be implemented. As a result of that, the application of the directive on infrastructure charges in the different European countries has given rise to a large spectrum of charging systems.

In recent years, the European Commission (EC), the European Conference of Ministers of Transport (ECMT) and some Regulatory Bodies, among other entities, have done an important research effort in the European rail infrastructure charging framework, in order to analyse the implementation procedure of the European legislation concerning charging for the use of rail infrastructure and to estimate the marginal costs, on which rail pricing systems should be based. However, there is an interest in appropriate and efficient mark ups above marginal cost which has still not been tackled.

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[1] Rail transport being more environmentally friendly than air or road transport.

While, as a general rule, urban or rural transit services lose money and have to be subsidised, intercity trains and especially high speed railways are able to generate cash surpluses. Therefore, high speed railways would be one market segment where the application of mark ups should be permitted.

Mark ups above marginal costs applied to high speed railways are unknown, but the frequent railway undertakings' complaints on the level of infrastructure charges may be hinting at the fact that the level of mark ups above marginal cost charged to high speed railways could be having a negative impact on the use of the European high speed network.

Given that the European Union is making an important effort to help finance and, consequently, build a European high speed network for strengthening railways and redressing modal share imbalances, it is of great interest to know if current charging levels could be negatively affecting the competitiveness of high speed services.

II. OBJECTIVES

The main objective of this PhD Thesis is to determine the impacts and, therefore, the consequences that current levels of rail infrastructure charges implemented in the European framework have on the competitiveness of the high speed passenger services that run on the European railway network.

Reaching this main objective requires reaching three consecutive main sub-objectives:

- To characterise the order of magnitude of a rail infrastructure charge for European high speed lines/services based on the marginal cost, which is the charging principle required by the European legislation.

- To characterise the rail infrastructure charging systems applied to European high speed services/lines, in order to detect if mark ups above the marginal cost of wear and tear are being applied to those services and if so, how they are applied.

- To quantify the impacts on traffic volumes and mode split resulting from bringing the current levels of rail infrastructure charges (applied in the European high speed network) to the level of marginal cost of maintenance and renewals and to the optimal Ramsey mark up.

III. CONTENTS AND STRUCTURE

The contents of this document have been structured into seven chapters.

Chapter 1 focuses on the introduction of rail infrastructure charges in the European Union. On a first stage, it tackles the reasons of their introduction in the European railway context and revises the principles of infrastructure pricing. On a second stage, it analyses the legislative pricing framework established by the European Commission. It ends with an estimation of the order of magnitude that rail infrastructure charges should have according to the legislative framework previously analysed. This last stage implies an in-depth revision of the estimation of marginal costs, on which European rail infrastructure pricing systems should be based.

In chapter 2 a state of the art of the main characteristics of rail infrastruture charging systems implemented in Europe are presented. Special emphasis is put on the analysis of cost allocation to charges for infrastructure use, in order to analyse the cost categories and variables used by the different pricing systems implemented in the European railway network. This analysis allows distinguishing special characteristics on the implementation of mark ups above marginal costs in pricing systems applied in networks where high speed lines are in operation. On the basis of these first results, the objective of this PhD Thesis is explicitly formulated.

The methodology established and the assumptions made for reaching the aforementioned objective are presented in chapter 3.

Chapter 4 presents an in-depth analysis of the structure and value of the charges for the use of rail infrastructure implemented in European countries with high speed lines in operation. Special attention is paid to the application of mark ups above marginal cost for high speed lines, in qualitative and quantitative terms. The search for similarities in the application of mark ups above marginal costs is analysed by an attempt of quantifying the influence that the consideration of wear and tear costs, investment costs and the commercial position of the market by pricing systems can have on the value of charges for high speed lines.

On the basis of the results obtained in chapter 4, chapter 5 deals with the analysis of the link existing between rail infrastructure charges and rail revenues from the ticket sales, as a preliminary stage before quantifying the impacts that actual prices charged to high speed trains are likely to have on high speed railways competitiveness.

In chapter 6 the impact that a reduction in rail infrastructure charges can have on traffic volumes and on mode split is evaluated for two case scenarios, namely: a reduction of rail infrastructure charges equivalent to reducing mark ups either to zero or to the optimal mark up.

The results of the previous chapters enable establishing the consequences that current levels of rail infrastructure charges implemented in the European framework have on the competitiveness of high speed passenger services running on the European railway network. Chapter 7 is devoted to the presentation of the conclusions and the possible further research envisaged by the PhD candidate.

IV. CONTRIBUTIONS

The main contributions of this PhD Thesis are:

- The detailed characterisation of high speed railways infrastructure charges and the analysis of the correlation of their value with infrastructure characteristics and their commercial position.
- The establishment of a methodology for quantifying the impacts on traffic volumes and mode split of a variation in the level of rail infrastructure charges.
- The quantification of the impact on European high speed traffic volumes of reducing mark ups either to zero, or to the optimal level of charges derived from the rule of the mark up proportinal to the inverse of the price elasticity of demand.
- The quantification of the impact on European high speed mode split of reducing mark ups either to zero, or to the optimal level of charges.
- Proving that the current level of infrastructure charges applied to high speed lines and services are negatively affecting the volumes and the market share.

CHAPTER 1

INTRODUCTION OF RAIL INFRASTRUCTURE CHARGES IN THE EUROPEAN UNION

1.1. REASONS FOR INTRODUCING RAIL INFRASTRUCTURE CHARGES IN THE EUROPEAN UNION

The development of high performance road infrastructures and air transport for the medium and long distance routes thanks to the introduction of the jet plane, headed railways in Europe to a declining situation in the late 1960s. Therefore, in the 1970s, railway in Europe stood as the most affected means of transport by the advance of aviation and the private car; indeed, in Europe, the growth in market share in the period 1970-1980 was of +2,0% for car transport, -1,9% for railways, -1,1% for bus transport and +1,05% for aviation (Sánchez-Borràs, 2004).

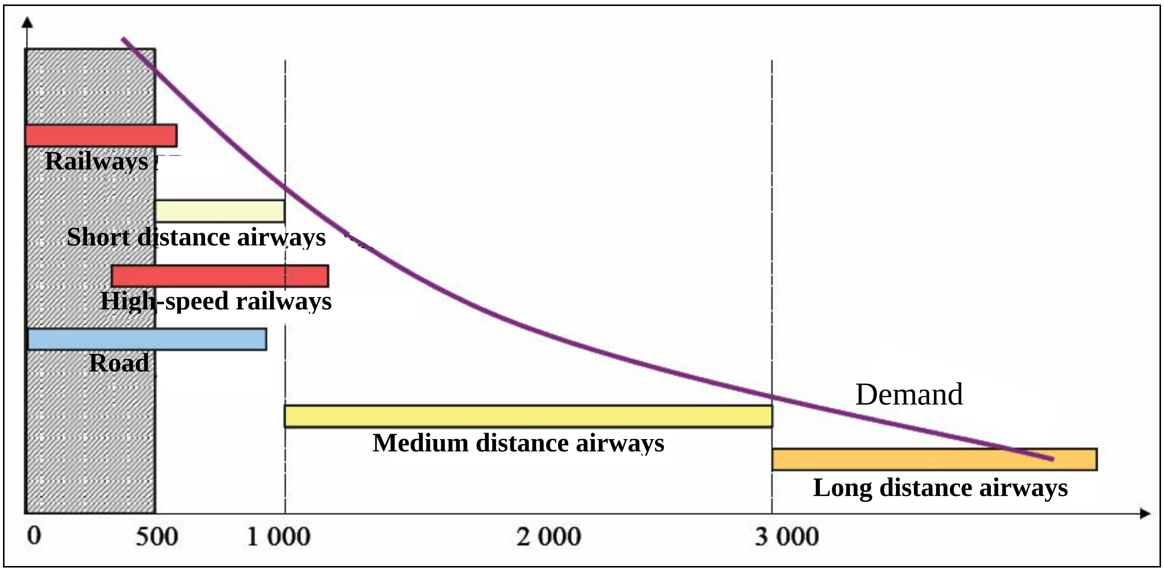
The measures undertaken at the European level to revitalise railways can be classified in two fields: a technical field and a legislative one.

With regard to the technical field, actions have focused on the construction of new railway infrastructures, mostly high speed lines, capable of allowing raises in commercial speeds and, consequently, converting railways, once again, into a competitive mode of transport. Annex A1 (“The European high speed network”) presents in detail the appearance of high speed railways and its context, and defines these new infrastructure and market segment, as well as their development since the 1980s to the present time.

The considerable increase in commercial speed that took place as a result of the great investments for the construction of new high speed lines and the upgrading of other lines (all of them detailed in annex A1), has resulted, as it was aimed for, in the broadening of the railway’s potential for competition against other modes of transport (see **figure 1.1**). However, the improvement of the railway’s situation does not only depend on the construction side, but also on the legislative one.

Regarding the legislative framework, railways in Europe are immersed in a great reform, aimed at improving the quality and the economic efficiency of railway services provision and stimulating growth on railway markets. Within the framework of this reform, defined by the European Directives, special mention has to be made to the restructuring of the sector. Annex A2 (“The restructuring of railways in Europe”) presents in detail in what the above mentioned restructuration has consisted (or is consisting), reviewing the traditional organisation of railways in Europe, analysing the different periods of the European Union (EU) railway politics since the 1950s to our days, and focusing subsequently on the first attempts of reorganisation of the railway in Europe and on the final reorganisation that has taken place.

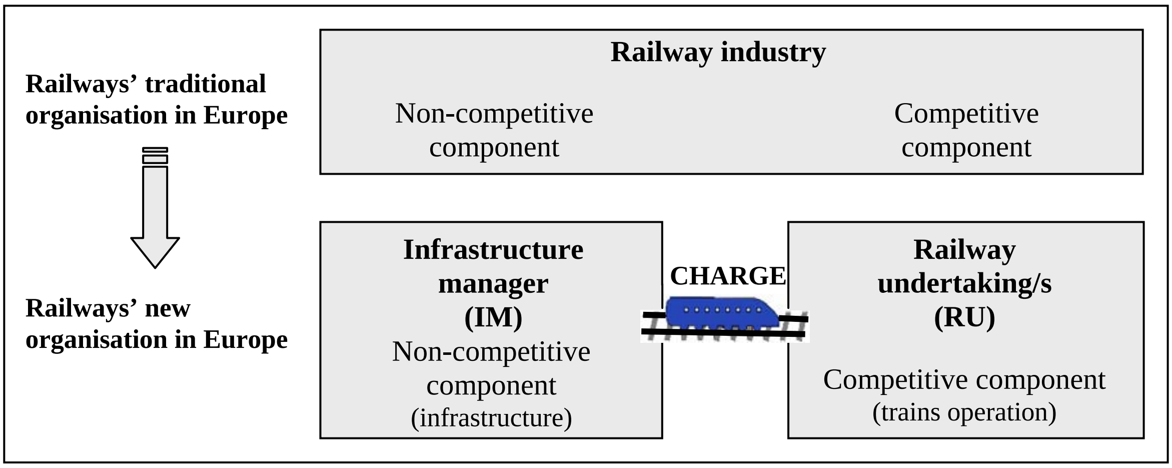
FIGURE 1.1 PONTENTIAL COMPETITIVITY BETWEEN MODES OF TRANSPORT
Source: LENOIR (?).



The restructuring procedure of the railway in Europe, presented in detail in annex A2, gave rise to the separation between the non-competitive component of the railway industry –the infrastructure– and the component that can be rendered as a competition regime –railway services–. The entities responsible for assuming the typical tasks of each component were named infrastructure manager (IM), in the case of the infrastructure, and railway undertaking (RU), in the case of railway services (see **figure 1.2**).

Given that RU’s trains must run on the infrastructure, managed by the IM, the need for establishing a tool regulating its use emerged. This tool was named charge for the use of rail infrastructure, also known as rail infrastructure charge. Before the reorganisation of the railway sector, rail infrastructure charges did not exist because the use of the track was an internal transaction within the railway company, i.e. the company in charge of the infrastructure maintenance had the exclusivity of using the tracks for its own trains.

FIGURE 1.2 VERTICAL SEPARATION BETWEEN RAILWAY OPERATION AND INFRASTRUCTURE IN THE EUROPEAN UNION AND APPEARANCE OF THE RAIL INFRASTRUCTURE CHARGE



The reorganisation of the railway sector to liberalise it and promote its competitiveness (and therefore raising its market share), has had positive effects on the efficiency of the European railway sector, as proven by a study carried out by Friebel et al. (2003), in which data for the period 1980-2003 is analysed. This data suggests that the reforms have had a positive effect on productivity (Calthrop, 2005).

On the other hand, separation between infrastructure management and operation has solved, to some extent, the historical railway debt; indeed, in Western Europe many railway companies have reduced their losses and some of them have even had little benefits, even if none of them is covering its capital costs (CE, 2005).

Even if the reorganisation carried out in the European railway sector seems to have borne good fruits, it is still unknown whether the introduction of rail infrastructure charges as a result of the separation between infrastructure management and operation has allowed or not strengthening high speed railways' competitiveness.

Previous to an analysis of the effects that rail infrastructure charges introduced in the European high speed network are having on the competitiveness of high performance railways, this chapter deals, first of all, with the definition and the strategic objectives of rail infrastructure charges; secondly, with the theoretical basis on the setting of charges; and finally, with the presentation of the legislative framework regarding rail infrastructure charges in the EU and an estimation of the order of magnitude that the charge should have according to the legal action guidelines established by the European Commission (EC).

1.2. DEFINITION AND STRATEGIC OBJECTIVES OF THE CHARGE FOR THE USE OF RAIL INFRASTRUCTURE

The charge for the use of rail infrastructure and its strategic objectives are defined below.

1.2.1. Definition of the charge for the use of rail infrastructure

While the ticket fare corresponds to the amount of money to be paid by a user for using a public mode of transport, such as for instance a train, the charge for the use of rail infrastructure corresponds to the amount of money paid by a railway undertaking to an infrastructure manager for running on its tracks and using its installations. That is, the rail infrastructure charge regulates the use of rail infrastructure (managed by an infrastructure manager) by a railway undertaking.

From a more strategic point of view, rail infrastructure charges can be defined as a “tool for modernising railways organisation and render it more efficient, that is, more able to face the competition of other modes of transport” (CEMT, 1998). This stems from the interrelation that exists between infrastructure charges and transport policies, as it will be seen in section 1.3.3.

According to the European Conference of Ministers of Transport (ECMT), a charging system should meet the following requirements:

- *No discrimination*: The charge should not be discriminatory, i.e. the infrastructure manager should treat in the same way all applications with identical offers made by different railway undertakings.

- *Transparency*: The requirements asked by the infrastructure manager should be known by all railway undertakings.

- *Attractiveness*: The charge should be such that the service provided, in this case transport, is attractive and, within the limits of the available capacity, increases the use of the infrastructure up to a level considered to be efficient.

- *Cost recovery*: The charge should enable reaching financial objectives defined by the infrastructure manager. This would enable for a partial cost recovery instead of requiring a total cost recovery.

- *Reflexivity*: The charging system should be based on empirically measurable calculation elements.

1.2.2. Strategic objectives of the rail infrastructure charge

The charge for the use of rail infrastructure reflects the following strategic objectives[2] (CEMT, 1998):

- To reach a better use of capacities (to favour the best possible use of the railway network).
- To direct investment options (participation in the maintenance and network operation cost recovery, as well as in the amortisation of investments, in particular investment for the renewal of installations).
- To foster productivity, i.e. to increase the economical efficiency. For this, productive and technical efficiency (to produce services at the least possible cost) as well as allocative efficiency[3] (resources must be oriented to the production of the goods and services most valued by society) must be increased.
- To reduce the necessity of resorting to public funds.
- To foster the rational and efficient use of the infrastructure, i.e. to stimulate the use and appropriate adaptation of infrastructure to traffic (to promote the use of railway transport and to participate in a balanced territory planning).

In order to reach these objectives, the structure and the level of charges should be comprehensible, transparent and stable (Bureau of Transport and Regional Economics, 2003).

---

[2] The strategic objectives of the charge for the use of infrastructure have not been classified by order of priority.

[3] To reach allocative efficiency and recover costs requires (Bureau of Transport and Regional Economics, 2003):

- That economies of density do not exist in long-run infrastructure provision and operating costs.
- That investment is optimal, so that at the prevailing demand, the efficient charge equals the long-run and short-run marginal costs.
- That there are no significant external costs and benefits of production.

Since rail infrastructure provision does not fulfil these conditions, access charges that are allocatively-efficient are unlikely to recover costs.

On the following section the tools available for setting the charge for the use of rail infrastructure are presented.

1.3. CONCEPTION OF THE CHARGE SETTING

With the aim of enabling railway operators to offer their services in proper conditions, it is essential that the infrastructure manager carries out an appropriate maintenance of the infrastructure, as well as the required planning and traffic management tasks for guaranteeing a coherent use of the network. These activities entail several costs that must be faced by the infrastructure manager with the collection of enough incomes to recover them.

In this sense, the conception of the charge setting requires, on one hand, to know the costs incurred and, on the other hand, selecting the costs that one wants to recover, that is, to choose a charging principle or philosophy, and to consider how one wants to recover them.

The next sections present, first of all, the definition of the different types of costs and subsequently, the theoretical charging principles.

1.3.1. Types of costs. Definitions

Costs can be of several types:

- On the one hand, costs can be classified as **fixed** or **variable**;
- On the other hand, costs can be classified as **total**, **average** or **marginal**;
- One can as well distinguish between **common** and **avoidable** costs;
- Finally, costs can be grouped into **private**, **external** or **social** costs

Many of these different types of costs can be combined between them. So, one can talk for instance of “total social cost” or of “marginal private cost”.

The different types of costs presented are defined below.

1.3.1.1. Fixed and variable costs

Fixed and variable costs are defined according to their variability contingent on the production level.

Fixed costs (C_F) are those costs that do not vary with the level of production, while, on the contrary, **variable costs** (C_V) are those that vary with the level of production.

It has to be stressed that both types of costs depend at the same time of the time period and the width of the considered variations in the production. So, on the very long-term, for instance, the only costs that can be defined as fixed are the non-recoverable costs of the investments carried out, while at the very short-term, most costs, except those of electric power and wear and tear, can be considered to be fixed.

This translates into the existence of different viewpoints for the different railway companies, since the time periods considered by them vary from one to another; indeed, certain railway companies consider that all supplementary costs registered when traffic is not equal to zero are variable costs. With this philosophy, all maintenance and renewal costs, as well as signalling and train running planning, can be defined as variable costs, since it is superfluous to carry out all these activities if the system is not used to run trains. On the contrary, other railway undertakings (such as for instance Network Rail in the United Kingdom), define as fixed those costs with which one must count no matter the traffic volume, given that different types of traffic run on the network. Consequently, those companies only consider variable those costs that vary with the traffic when this exceeds a given volume. In this case, a huge number or even most part of the maintenance, signalling and train running planning cost elements can be considered to be fixed.

The differences presented in the preceding paragraph help to explain the fact that in one company fixed costs can represent 90% of total costs, as it is the case of Railtrack[4], while in other companies they can represent lower percentages (for instance, 75% of total costs in the case of SNCF[5] (Profillidis, 2001)).

1.3.1.2. Total, average and marginal costs

Total costs (C_T) constitute the whole of the costs imposed by the production of a certain amount of goods or services. Consequently, in the railway field, total costs represent the total yearly cost of infrastructure provision.

Mathematically they can be defined as the sum of fixed and variable costs (or of investment and management costs):

$$C_T = C_F + C_V \quad \text{with } C_F = \text{fixed costs and } C_V = \text{variable costs} \qquad \text{(f. 1.1)}$$

---

[4] Since 2002, Network Rail, rail infrastructure manager of the United Kingdom.

[5] Société Nationale des Chemins de Fer, French railway company.

Average costs ($\overline{C}$) are defined as the total cost per production unit of a good or a given service, i.e. the total cost divided by the level of production. Mathematically it can be expressed as follows:

$$\overline{C} = \frac{C_F(x)}{x} + \frac{C_V(x)}{x} \quad \text{with x = volume of production} \qquad \text{(f. 1.2)}$$

The average cost is a fundamental element for the setting of prices: if prices exceed the average cost, the company will have benefits; if, on the contrary, they are lower than the average cost, the company will have losses.

The **marginal cost** (MC or C_M) corresponds to the supplementary cost imposed by the production of a supplementary unit of a good or service, i.e. it corresponds to the evolution of the total cost in case of producing one or several extra units. More precisely, in the railway field the marginal cost corresponds to the variation of infrastructure costs, when a unit of additional traffic uses the tracks (Finnish Rail Administration, 2007).

Mathematically, the marginal cost can be expressed as follows:

$$C_M = \frac{dC_T(x)}{dx} = \frac{d(C_F + C_V)(x)}{dx} = \frac{dC_V(x)}{dx} \qquad \text{(f. 1.3)}$$

and cuts the average costs curve at the minimal value of $\overline{C}$, obtained from equaling to zero its derivative:

$$x = \frac{C_F + C_V(x)}{\frac{dC_V(x)}{dx}} \qquad \text{(f. 1.4)}$$

In the railway field, marginal costs may encompass the following elements (CE, 1997):

- Operation costs: energy, labour and certain maintenance expenses.
- Costs related to the wear and tear of the infrastructure: maintenance and infrastructure wear and tear expenses, such as the repair of tracks.
- Costs linked to congestion[6] and scarcity of capacity[7]: cost of the delays caused to users and non-users due to traffic jams, for instance, queues at stations. In addition,

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[6] **Congestion costs** refer to the costs caused by additional delays to other services resulting from running an extra train.

the use of an infrastructure by a transport operator may hinder its use by another operator.

- Environmental costs: air, as well as noise pollution.
- Costs linked to accidents: costs in terms of material damages and losses in production.

The marginal cost can be of two natures:

- On the one hand, one can talk of the **short-run marginal cost** (SRMC), which is defined as a specific variable cost linked to the use of the existing infrastructures, without considering the raise in capacity (CE, 1997). Consequently, the SRMC assumes that some inputs of the cost function are fixed (such as, for example, infrastructure).

- On the other hand, one can talk of the **long-run marginal cost** (LRMC): This cost differs from the short-run marginal costs because it also considers the costs derived from future capacity increases. Those costs are very difficult to calculate in the transport field.

Both short-run and long-run marginal costs can vary with an increase of the number of runs, as seen in **figure 1.3**, since marginal costs incorporate congestion costs. In the short-run, marginal costs do not consider the increase in capacity. Therefore, the increase of runs implies an increase of the congestion and scarcity costs, until no action is taken on capacity. In the long-run, these variations with the increase of the number of runs will depend on the period considered. In a 50-year term all costs (even investment costs) become variable and, therefore, long-run marginal costs tend to converge with average costs, since the distinction between fixed and variable costs disappears.

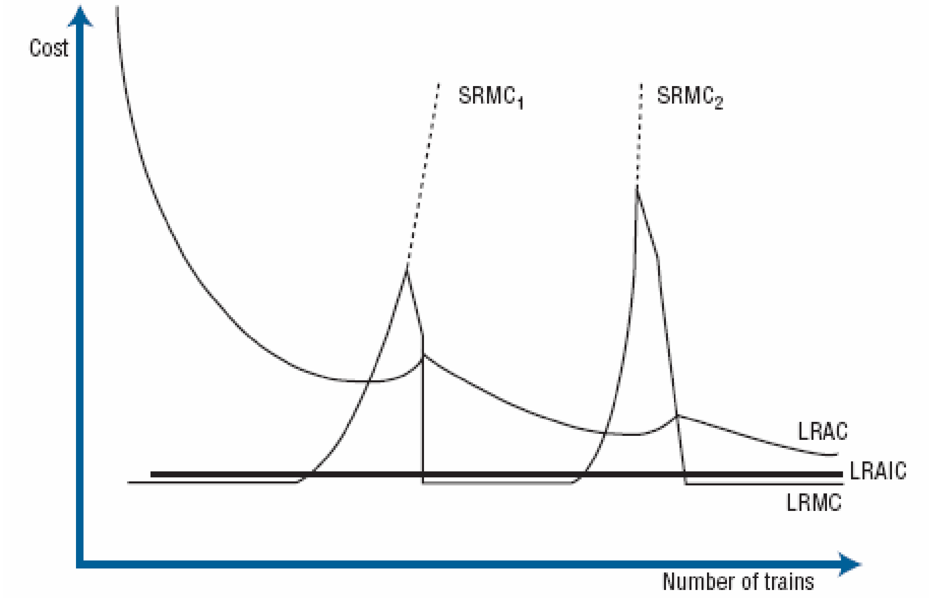
When the use of the infrastructure is above its optimal capacity, the long-run marginal costs are lower than the short-run marginal costs. On the contrary, when the use of the infrastructure is below the optimal capacity, the long-run marginal costs are higher than the short-run marginal costs.

---

[7] **Scarcity costs** refer to the costs of not being able to run a train or not being able to run it at the preferred time.

FIGURE 1.3 EVOLUTION OF SHORT-RUN AND LONG-RUN MARGINAL COSTS CONTINGENT ON THE NUMBER OF RUNS

Source: Bureau of Transport and Regional Economics (2003).



SRMC: Short-run Marginal Cost
LRMC: Long-run Marginal Cost
LRAC: Long-run Average Cost

1.3.1.3. Common and avoidable costs

Common costs (C_C) are those costs derived from the production of more than one good or service, i.e. they correspond to the costs due to several runs. Those costs can only be avoided in the case the production of all of these goods or services ceases, that is, in the railway field, if several types of services are withdrawn. For example, let us suppose that a double track is used by local passenger services, fast passenger services and freight services. This line could be put in operation as single track if two of the three types of services did not run: in that case the maintenance costs of the second track would be common.

Common costs have to be borne by someone but if they are allocated to users, it must be done according to methods that do not distort the decisions concerning the level of services offered.

On the other hand, **avoidable costs** (C_{AV}) are those costs that would be avoided if a good or a service would no longer be produced, in particular when other goods or services that share common costs continue to be produced. In the railway field, it can be affirmed that avoidable costs for a particular type of traffic correspond to variable costs, since the cost of such traffic adds to all fixed costs that would be avoided if traffic ceased. Therefore, certain costs related to the offer of high speed transport can be fixed as far as high speed trains run on the network, but they will be avoidable if the network only receives slower trains.

The analysis of the avoidable costs is of great utility when deciding which are the desirable characteristics of the railway network in terms of quality and capacity. The infrastructure needed for particular types of service can only be guaranteed if someone (be it the public stakeholders, be it the users) is willing to assume the avoidable costs, and it is convenient to allocate these costs to the type of traffic in question as a fixed charge, which will only vary in the long term when it is decided to modify the quality and the infrastructure capacity (CEMT, 2005).

1.3.1.4. Private, external and social costs

Private costs (C_P) or **internal costs** are those costs incurred by the supplier of the good or service in question. For example, for an infrastructure, private costs are those borne by the infrastructure manager, that is, infrastructure costs (construction, maintenance) and operation costs.

With regard to **private marginal[8] costs**, they generally comprise the costs linked to wear and tear (that can cause supplementary maintenance costs and the speed up of renewal of certain installations) and a part of the planning and trains operation costs.

External costs (C_{EXT}) are those imposed to a third party on the occasion of the supply of goods and services. In the case of the railway industry they correspond to environmental costs (noise, air pollution and global warming costs) and, possibly, certain accident costs and those related to congestion and scarcity of capacity.

Finally, **social costs** (C_S or SC) are defined as the sum of private costs (C_P or PC) and external costs (C_{EXT} or EC). Formula f. 1.5 states their mathematical expression, while **figure 1.4** corresponds to its graphical representation:

$$C_S = C_P + C_{EXT} \qquad \text{(f. 1.5)}$$

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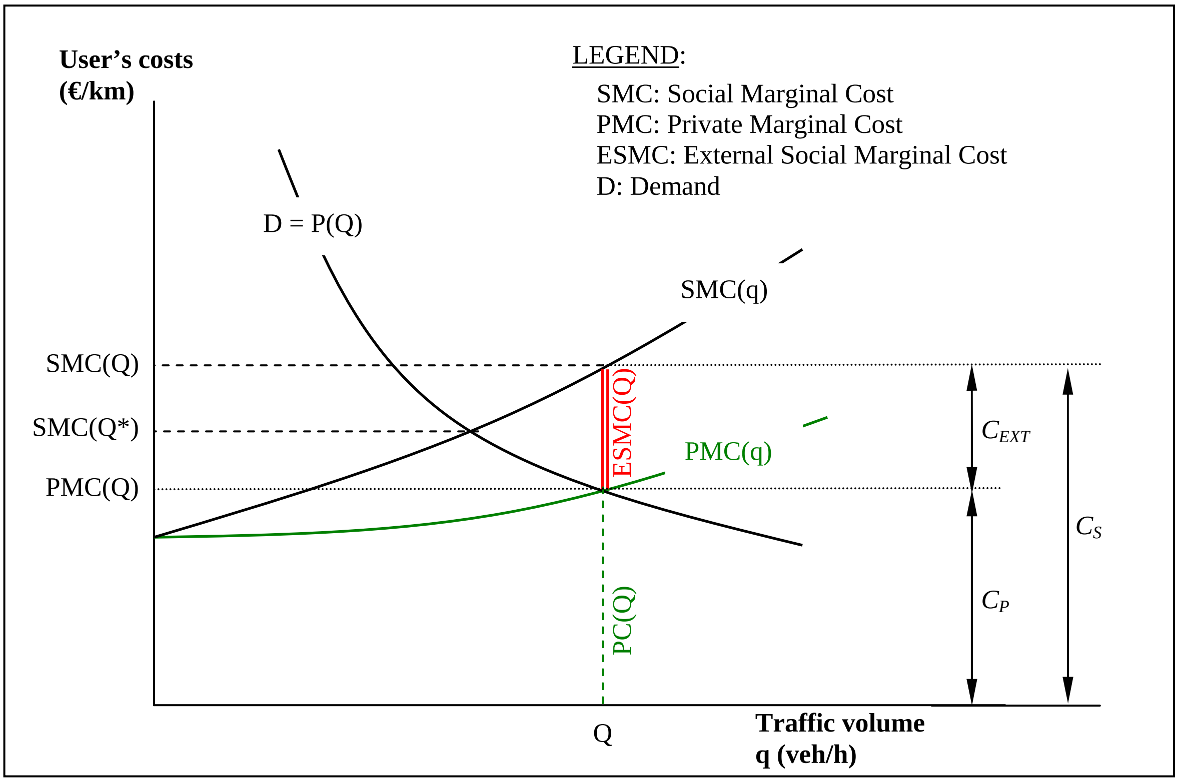
[8] Short-run marginal costs.

FIGURE 1.4 ILLUSTRATION OF THE SOCIAL, PRIVATE AND EXTERNAL MARGINAL COSTS



1.3.2. Charging principles and philosophies

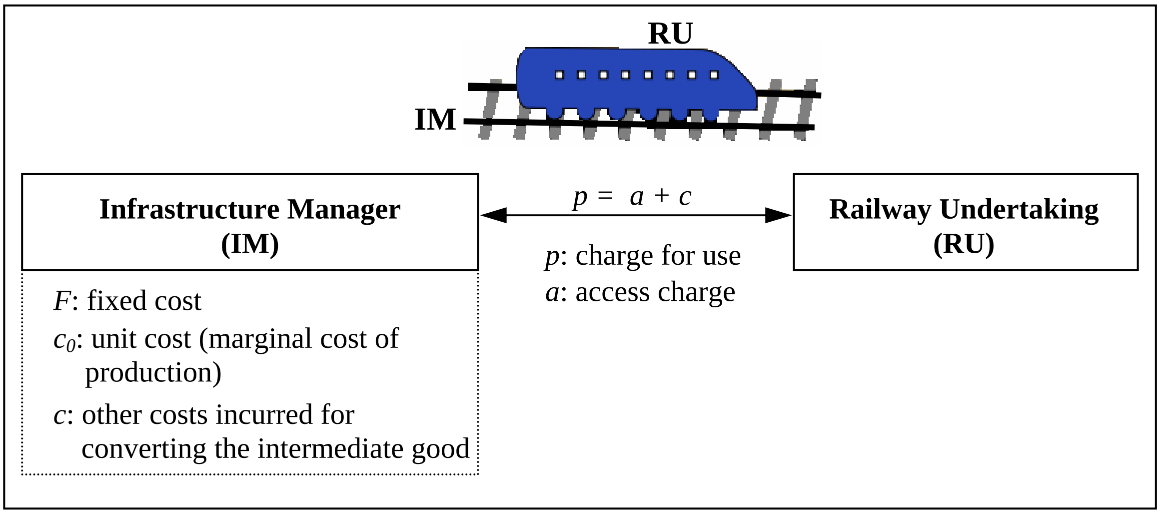
1.3.2.1. Introduction. The marginal cost as reference point for charging

The link between the infrastructure manager and the railway undertaking can be defined as follows (Valletti et al, 1998):

In order to provide one unit of final good, that is the movement of trains, railway undertakings need one unit of the infrastructure manager's input: planning and infrastructure management. This input is produced at a unit cost c_0. On the other hand, the infrastructure manager (IM) incurs a fixed cost F, which can be interpreted as the set up cost of the network, or some other costs deriving from social obligations that cause losses to it. In addition, the IM charges a unit access charge a to users, i.e. railway undertakings (see **figure 1.5**).

Bearing in mind the fact that one of the objectives of the rail infrastructure charge consists in inducing railway undertakings to raise their efficiency and therefore reach levels of runs that favour users (see section 1.2.2), the level of the charge should be set so that the social

FIGURE 1.5 LINK BETWEEN THE RAIL INFRASTRUCTURE MANAGER AND A RAILWAY UNDERTAKING IN TERMS OF COSTS



welfare (SW) is maximised. Graphically (see **figure 1.6**), the maximisation of the social welfare can be visualised as the maximisation of “dec” (which corresponds to the consumers’ surplus –CS–) and “ceka” (which represents the producer’s surplus –PS–) areas. These areas reach their maximal value when the area “efk” (known as “deadweight loss”) is equal to zero, situation that takes place when the marginal cost is charged. Consequently, the deadweight loss corresponds to the economical loss derived from charging above the marginal cost. Mathematically, the maximisation of the social welfare can be expressed as follows:

$$\frac{dSW}{dQ} = 0 \qquad \text{(f. 1.6)}$$

Be it also:

$$\frac{d(TR + CS - TC)}{dQ} = 0 \qquad \text{(f. 1.7)}$$

$$\frac{d(TR + CS)}{dQ} = \frac{dTC}{dQ} \qquad \text{(f. 1.8)}$$

where:

- *Q* corresponds to the traffic volume
- *TR* are the total revenues of the producer (area “oceg”)
- *CS* are the consumers’ surplus

- *TC* is the total cost of producing a quantity q, without considering fixed costs

The left part of the expression f. 1.8 corresponds to the area that lies under the demand curve D. Being:

$$D = P(Q) \tag{f. 1.9}$$

the left part of the expression f. 1.8 can be expressed as:

$$TR + CS = \int_{0}^{Q} P(Q)dQ \tag{f. 1.10}$$

$$\frac{d}{dQ}(TR + CS) = P(Q) \tag{f. 1.11}$$

On the other hand, the right part of the expression f. 1.8 corresponds to the marginal cost (f. 1.3). Therefore, combining the expressions f. 1.8 and f. 1.11 we obtain:

$$P(Q) = \frac{dTC}{dQ} = MC \tag{f. 1.12}$$

This proves mathematically that social welfare is maximised when the price equals marginal cost. In other words, marginal cost pricing should be adopted for maximising social welfare[9]. Consequently, in economic terms it is considered that marginal cost pricing corresponds to the best theoretical situation and it is therefore called “first best”. On the contrary, charging above marginal cost is called “second best”. **Figure 1.6** clearly shows these two theoretical solutions.

It has to be highlighted that for the optimal theoretical solution of charging (first best) to be able to take place in practice, that is, for additional benefits in the market to be reduced to zero, it is required that railway undertakings seek to increase their efficiency and improve their level of production. This situation is only possible if there does not exist any source of distorsion in the market, i.e. if there exists a perfect competition and if all railway undertakings of the competitive sector are similar (in terms of technology and costs) and their products are identical.

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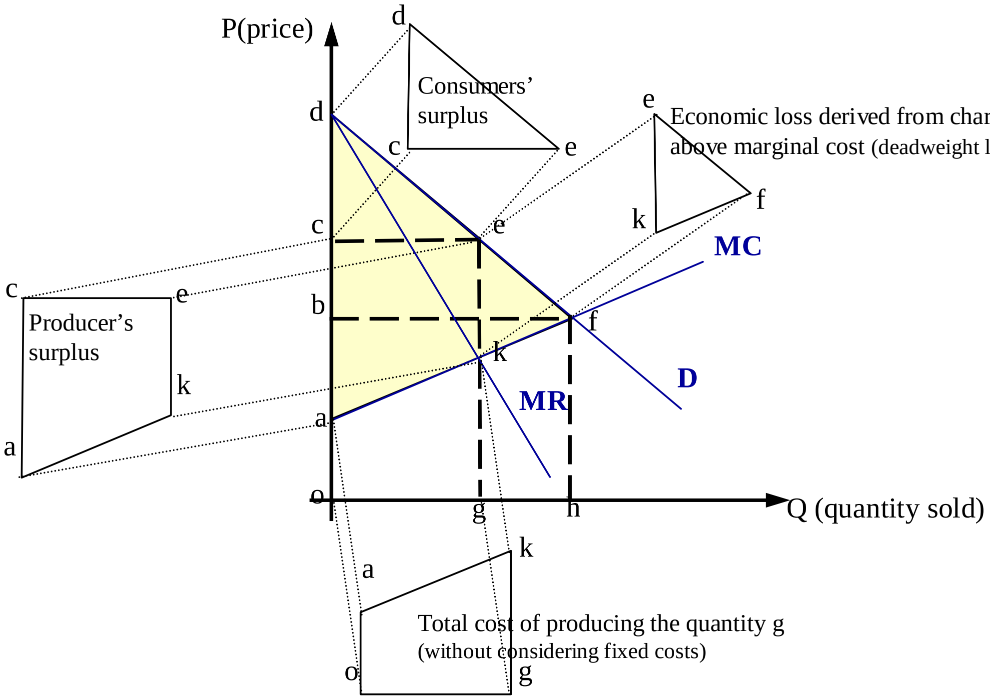
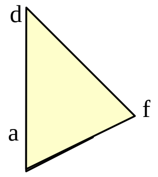
[9] The proof that marginal cost pricing is enough for optimising social welfare was formulated by Hotelling in his book “The general welfare in relation to problems of taxation and of railways and utility rates” (Hotelling, 1938).

FIGURE 1.6 MARGINAL COST CHARGING (FIRST BEST) AND CHARGING ABOVE MARGINAL COST (SECOND BEST)

Curves:
- D: demand
- MC: marginal cost curve
- MR: marginal revenues (change in revenues produced if the infrastructure manager reduces its price enough so as to sell an additional unit: MR = p·(1+1/ε))

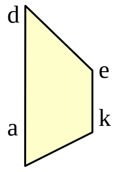


Social Welfare = (Total producer's revenues) + (Consumer's surplus) – (Production costs) =
(SW) = (oceg) + (ced) – (oakg) =
= (acek) + (cde) =
= (Producer's surplus) + (Consumers' surplus)



First Best : SW = $SW_{maximal}$

(P = marginal cost)



Second Best: SW < $SW_{maximal}$

(P > marginal cost)

The subsequent sections deal with marginal cost pricing (first best) and charging above marginal cost (second best) in depth.

1.3.2.2. First best charging. Marginal cost charging

As introduced in the preceding section, if it does not exist any source of distortions in the market, the best charging system that can be applied is marginal cost pricing, because the lower the access tariff (*a*) is, the lower the final charges (*p*) will be and, consequently, the higher the final amount consumed by the final users will be, i.e. the higher the number of trains runs will be.

Therefore, in a marginal cost pricing system, the charge for the use (*p*) should be equal to the marginal cost of production; thus, the access tariff (*a*) should be equal to the marginal cost of production:

$$p = a + c \qquad \text{(f. 1.13)}$$

with: a = c_0 = marginal cost of production
c = other costs incurred for transforming the intermediate good

so:

$$p = c_0 + c \qquad \text{(marginal cost pricing)} \qquad \text{(f. 1.14)}$$

There are two types of marginal cost pricing, depending on the type of marginal cost considered (**short-run marginal cost**, **long-run marginal cost**, or **social marginal cost**). The advantages and disadvantages of the short-run and long-run marginal cost pricing, leaving aside the inherents inconvenients to all marginal costs[10], have been summarised in **table 1.1**.

With regard to (short-run) marginal social cost charging[11], it requires external costs to be reflected by means of a pigouvian tax[12]. The pigouvian tax, the aim of which is to correct the effects of negative externalities, corresponds to the difference between the social marginal costs curve and the private marginal costs curve at the equilibrium point between the social marginal cost and the demand (see **figure 1.7**).

From a theoretical point of view, marginal social cost charging is the best solution in terms of economical efficiency (CEEE/UAL-CEGEA/UCP,?). However, it can mean a barrier for railways if this principle is not applied in the other modes of transport. To this drawback it has to be added the fact that this charging principle does not reflect the contributive capacity of transports and, consequently, it can induce a reduction of certain traffics for other new traffics.

---

[10] They consist in the dependence on the State contributions to the infrastructure manager so that the latter can face the deficit, and in the difficulty of determining marginal costs, which require detailed studies for evaluating the costs related to the run of an extra train.

[11] When talking about marginal social cost, one generally refers to the short-run social marginal cost and not to the long-run marginal cost.

[12] Those are named after the economist Arthur Pigou (1877-1959), who established, in 1924, the optimal fee for internalising external costs.

TABLE 1.1 ADVANTAGES AND DISADVANTAGES OF CHARGING BASED ON SHORT-RUN AND LONG-RUN MARGINAL COST

Source: Author's elaboration from Hylén (1998), Bureau of Transport and Regional Economics (2003), EC (2004), CEMT (2005).

	Advantages	Disadvantages
SRMC	- Promotes the eficient use of the network, maximising welfare.	- Possible problems at the planning stage, since charges based on this principle may change with time and space (Hylén, 1998). - Given the long term required for extending the capacity of the infrastructure, short-run marginal cost pricing hardly gives signals to temporary investment. - Makes it difficult to incentivise the infrastructure manager.
LRMC	- Incentivises the infrastructure manager to invest and to extend the network where the demand exceeds capacity. - Avoids the difficult calculations of congestion costs.	- Some railway undertakings that could pay the short-run marginal cost may be excluded from the market. - Needs calculations of investment expenses, often difficult to do.

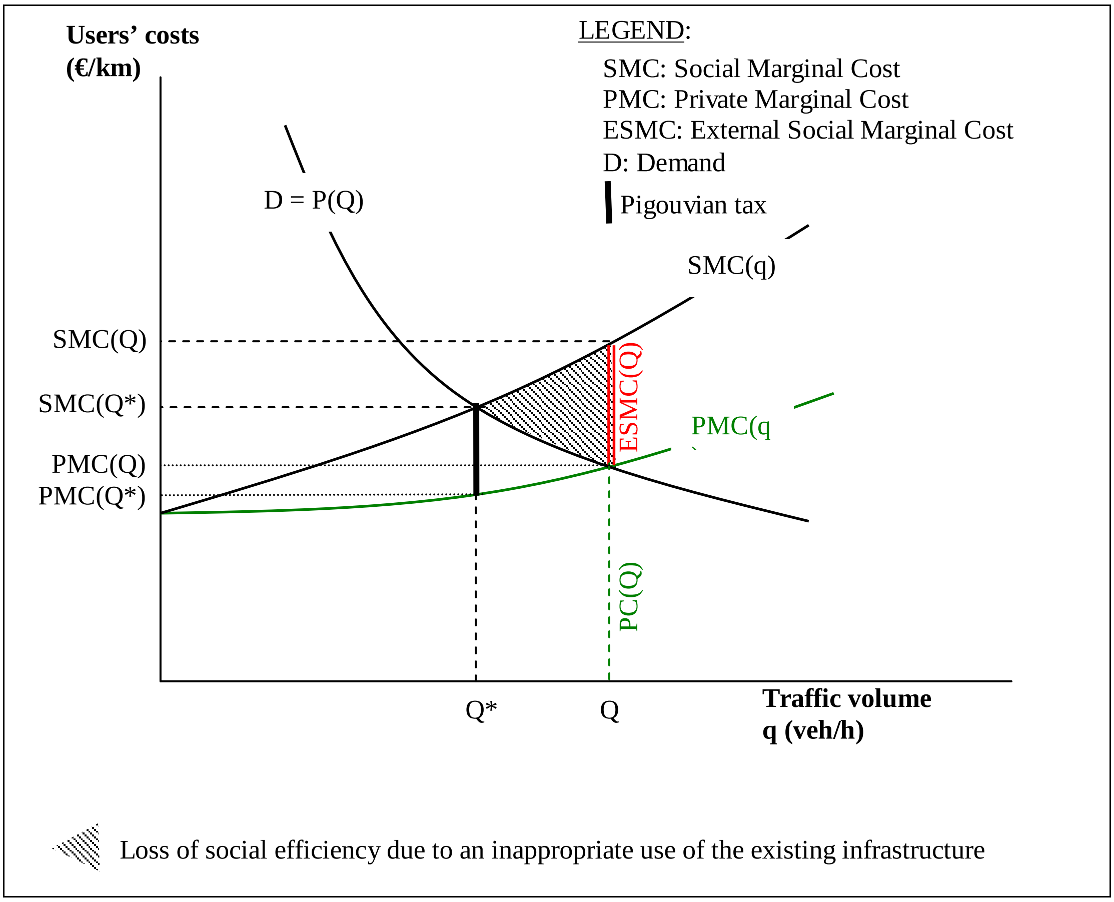
Remarks:

- SRMC: Short-run marginal cost
- LRMC: Long-run marginal cost

According to CEMT (2005), it is not desirable to have the product of the pigouvian taxes going to the infrastructure manager, since it could incite it to earn more money by attracting more polluting trains. Therefore, CEMT (2005) considers that the product of the pigouvian taxes should go directly to the State.

In its most elaborated form, known as harmonised social marginal cost, it involves taking into account the external costs derived from all modes, and organising eventual compensations between the modes if one of them does not cover its social marginal cost, while the other do.

FIGURE 1.7 DEFINITION OF THE PIGOUVIAN TAX



1.3.2.3. Second best charging. Charging above the marginal cost

While marginal cost charging is considered to be the optimal charging solution ("first best") from a theoretical point of view, in practice this solution cannot always be reached. This is because the fact that the access tariff (*a*) is equal to marginal costs of production (c_0) only allows recovering variable costs and, as a result of that, the infrastructure manager would have losses equal to the fixed costs (*F*).

The philosophy that lies behind marginal cost charging consists in letting the State cover the difference between the marginal cost and the financial cost. However, if State financing is not enough for recovering fixed costs, it is necessary to charge above marginal cost, applying the second charging optimum ("second best").

Second best charging seeks, therefore, to set an efficient access charge subject to the infrastructure manager's budgetary constraints. There are several ways of setting it: on the one hand, setting a charge above marginal cost based on costs; on the other hand, setting a charge above marginal costs based on the market.

Charging above marginal cost based on costs allows recovering the costs directly attributable, as well as allocating at least some of the common and fixed non-attributable costs. This type of charging is characterised by the fact that the level of usage of the track defines the level of charge and by the fact that it is not based on the determination of marginal costs in order to determine its level[13], but on the total distribution of average costs.

Charging above marginal cost based on the costs gives rise to two charging principles, depending on the State contributions:

- *Full cost recovery or total cost charging (FC[14])*: Full cost recovery, also known as total cost charging, is based on the determination of levels of charges for the use of the infrastructure that allow a total cost recovery of the infrastructure manager's fixed and variable costs. This charging principle is appropriate in places where railway transport is the predominant mode of transport and its market position is strong, as for instance in the Baltic States (CER, 2005b).

- *Full cost recovery after State subsidies (FC-)*: The full cost recovery after State subsidies principle responds to a charging conception based on the point of view of the infrastructure manager, which has to operate as a commercial organisation, because it has to recover its costs. Specifically, it determines the infrastructure charge beginning with the knowledge of two variables: total financial costs and State contributions. Therefore, if the infrastructure manager's costs rise, the levels of charges rise in the same proportion. Therefore, no incentives for reducing costs exist.

Both types of charging do not allow introducing incentives for cost reduction, given that if the infrastructure manager's costs rise, the levels of charges will rise in the same proportion.

On the other hand, **charging above marginal cost based on the market** (also known as price discrimination charging) consists in charging marginal costs with mark ups (marginal cost with mark ups, MC+), that is, charging marginal costs applying to them some mark ups aimed at reducing the need for State contribution. The mark ups applied can be fixed (i.e. applicable to all market segments) or variable according to the demand categories (see **figure 1.8**).

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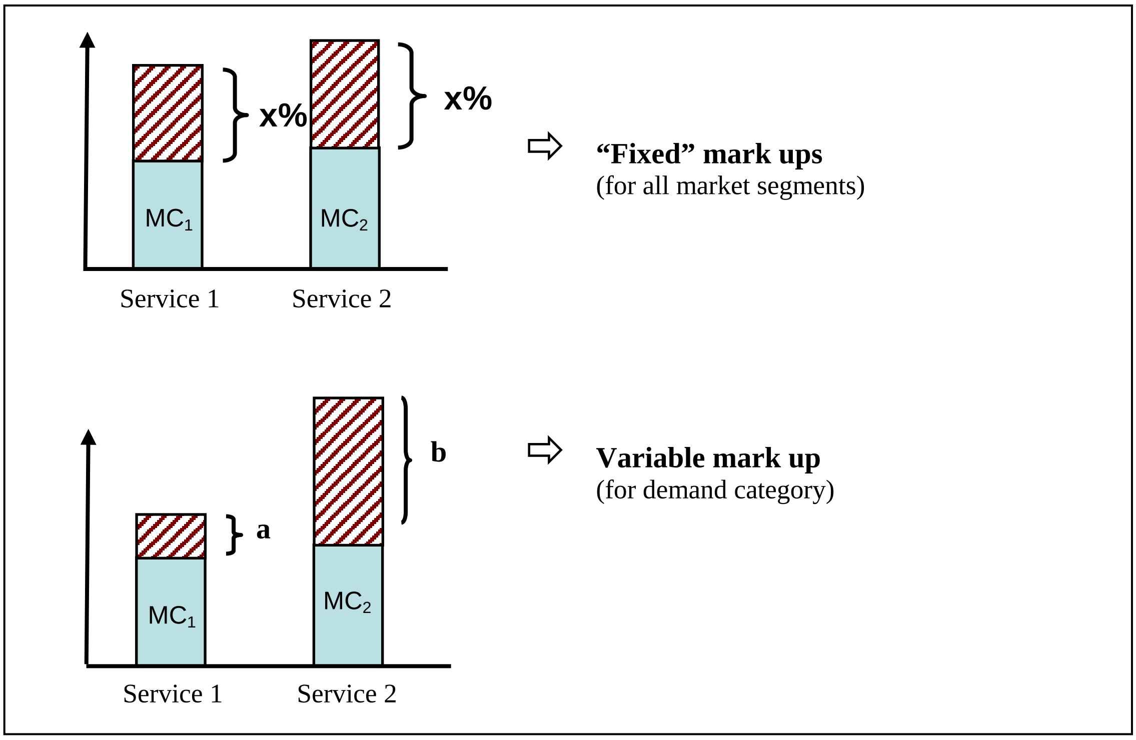
[13] Even if the marginal cost is not used to determine the charge in the full cost recovery after subsidies principle, it is important for the infrastructure manager to know its value, as well as the railway undertakings' elasticities, in order to recover the costs in the most efficient way.

[14] FC stands for Full Cost.

FIGURE 1.8 CHARGING ABOVE MARGINAL COST PRICINPLE BASED ON THE MARKET
Source: Taken from Teixeira (2006).



When fixing mark ups it is important to take into consideration the impact that their level can have on the competitiveness of railways. Therefore the charges are set at levels that reflect the predominant demand levels and the price elasticities, i.e. they reflect railway undertakings' ability to pay.

As it will be seen in section 1.4.1, the marginal cost with mark ups pricing principle is the one required by Directive 2001/14/CE[15] and the one applied by most Western European countries. Its application can be done according to three levels:

- *First degree of price discrimination*: It consists in charging a different price to each operator. Specifically, it consists in charging below the demand curve, which reflects the users' willingness to pay.

- *Second degree of price discrimination*: It consists in charging different prices to railway undertakings operating in a same (sub)market. Linear and two-part tariffs (application of fixed mark ups) belong to this group.

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[15] Directive 2001/14/EC refers to the allocation of railway infrastructure capacity, the levying of charges for the use of railway infrastructure and safety certification.

- *Third degree of price discrimination*: It consists in applying different tariffs in different market segments (application of variable mark ups by demand category). This price discrimination is known as Ramsey pricing.

The next paragraphs describe in detail what those three types of charging are: charging by total distribution of average costs (fully distributed average cost pricing), charging with a two-part structure and Ramsey pricing (pricing discrimination).

Fully distributed average cost pricing

This charging tool is based on the theoretical case that all railway undertakings of the competitive sector are similar (in terms of technology and costs) and that, consequently, they offer similar final services.

Under these conditions, the total amount of production supplied by the infrastructure manager in equilibrium with the railway undertakings depends on the access tariff ($Q^S(a)$: amount supplied). This implies that the infrastructure manager will be able to balance its accounts only if the charge for the use of railway infrastructure recovers the fixed costs on average, that is, if:

$$a = c_0 + \frac{F}{Q^S(a)} \qquad \text{(f. 1.15)}$$

with: c_0 = marginal cost of production
F = fixed costs
$Q^S(a)$: amount of total production supplied by the infrastructure manager

Given the expressions f. 1.13 and f. 1.15, and taking into account that the quantity supplied by the infrastructure manager should be equal to the quantity requested by the operators ($Q^D(p) = Q^S(a)$), the implicit formula of the access tariff by total distribution of average costs is the following one:

$$a = c_0 + \frac{F}{Q^D(a+c)} \qquad \text{(f. 1.16)}$$

Consequently, the fully distributed cost pricing distributes amongst the operators the fixed and common costs that cannot be directly allocated to some of them[16]. This distribution of costs can be done according to different parameters (Peter, 2003), generally linked with

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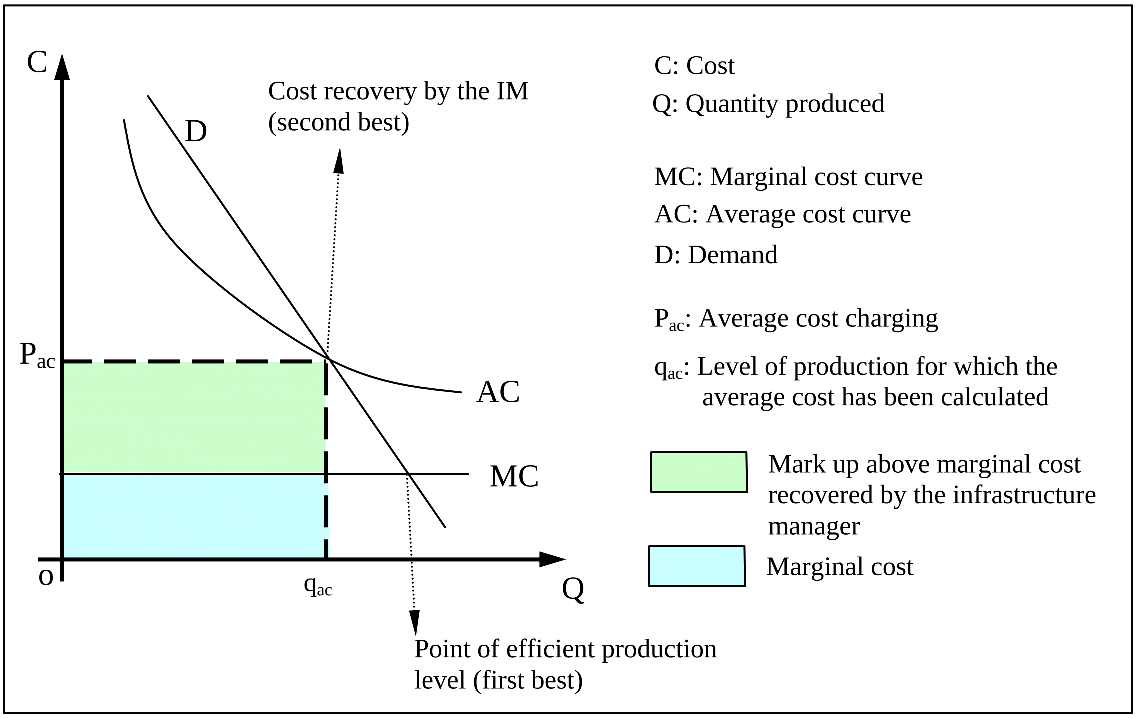
[16] Toner et al (2008) point out the difficulty of distributing common costs, which lies in the fact that they cannot be uniquely attributed to one output and that there is no cost-allocation method that is demonstrably theoretically superior to any other.

the use of the infrastructure or linked with an estimation of the cost caused. Amongst the methods used stand out the distribution of costs according to the number of train-km run, the distribution according to the market share of each operator (it can be measured in tonnes-km, but this would be detrimental to freight operators), the distribution according to gross revenues and the distribution according to the attributable cost, that is, according to the cost they cause. Therefore, average costs indicate the costs of tuning up the infrastructure by unit of traffic (CE, 1997).

FIGURE 1.9 FULLY DISTRIBUTED AVERAGE COST PRICING



In **figure 1.9** the fully distributed average cost pricing principle has been outlined. It has to be highlighted that this method eliminates every notion of marginality (Toner et al, 2008).

Even if this approximation is quite simple, it can lead to a lack of efficiency, forcing certain operators to pay too high a tariff (if marginal costs are low) and other operators to pay too low a tariff. This can result in the exclusion of certain operators that could pay the marginal cost of using the infrastructure. In addition, the fully distributed average cost pricing can hinder the introduction of competition in the network, favouring the perpetuation of the big existing operators.

Charging with no-linear or two-part structure

While simple or linear tariffs are usually associated with systems based on marginal costs, the basic idea of no-linear tariffs consists in charging every train-path according to its marginal cost and recovering the deficit by means of a fixed tariff (independent of the quantity consumed) that the operator has to pay as access tariff or reservation tariff (Peter, 2003).

Generally, the fixed part of non-linear tariffs refers to fixed costs[17], while the variable part is based on variable costs[18]. However, it has to be stressed that the so-called "fixed" element often depends on the forecast system usage. Therefore, this label can be misleading.

According to economic theory, the basic form of a two-part tariff is the following one:

$$P = A + p \cdot q \qquad \text{(f. 1.17)}$$

where:

- $A = F / n$ is the fixed part, which corresponds to the access tariff, and can be expressed as the link between the deficit that the company would have if the marginal cost was charged (*F*) and the number of operators (*n*).
- *p* is the marginal price
- *q* corresponds to the quantity of product consumed

Despite having attractive properties for the allocative efficiency, non-linear tariffs can be discriminatory in a free access situation, since they can involve an entry barrier if an operator can pay the marginal costs but cannot face the fixed costs imposed (this case can take place when *p* is equal to the marginal cost and *A* is higher than the consumer's surplus of some operators). Small operators are the most vulnerable, because if no difference is made between the level of use and the fixed part is the same for everyone, the effort that small operators have to do to face this fixed part is much higher. Pietrantonio et al. (2004) argue that with two-part tariffs, a new operator, almost inevitably, pays either a higher marginal charge per train-km or a much higher fixed charge in comparison with its level of business. It is for this reason that the European Union is reluctant to accept two-part tariffs.

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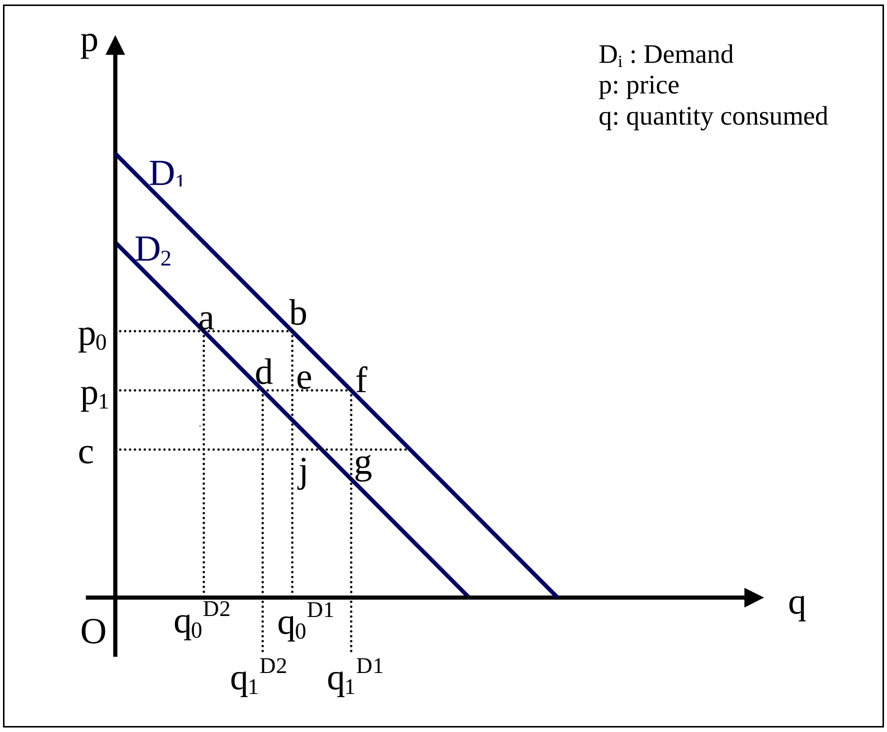
[17] Fixed costs are those that do not vary with the production level. It has to be highlighted that those costs considered as fixed depend at the same time on the time period and the width of the variations in production considered.

[18] Variable costs are those that vary according to the level of production. As with fixed costs, these costs vary with the width of the variations in production and the time period considered.

FIGURE 1.10 TWO-PART TARIFF



In order to avoid possible discriminations, in some cases it has been proposed to apply the two-part tariff in an optional way (with autoselection), so that one operator can choose between a linear tariff with a unit price $p_0 > p$ and a two-part tariff with an access tariff A and a unit price $p < p_0$. **Figure 1.10** schematises, for an operator with a demand D_1 (high demand) and another operator with a demand D_2 (low demand) in a same market, how the autoselection would work: on the one hand, the operator with high demand (D_1) would prefer the two-part tariff, while the operator with low demand (D_2) would choose the linear tariff. Indeed, the choice of paying a linear tariff p_0 for each unit of product consumed would imply a level of consumption q_0^{D1} and q_0^{D2}, while the choice of paying a two-part tariff would imply to pay an access tariff A equal to the area "p_0bep_1" defined in **figure 1.10** (higher than the linear tariff that the operator with low demand would pay) plus a variable charge equal to $p_1 < p_0$, that in the case of the operator with high demand would allow to raise its consumption to q_1^{D1} as well as its surplus (increased in "*bef*") and at the same time the producer's surplus (that is, in the present case, the IM's surplus) would increase in "*efgj*".

In **table 1.2** the main characteristics, advantages and disadvantages of linear (or simple) and non-linear (or two-part) tariffs have been summarised.

TABLE 1.2 CHARACTERISTICS, ADVANTAGES AND DISADVANTAGES OF LINEAR AND TWO-PART TARIFFS

Source: Author's elaboration with data from CEMT (2005) and Bureau of Transport and Regional Economics (2003).

	Linear tariffs	Two-part tariffs
Characteristics	- Directly variable with measures of use: · gross tonne-km · net tonne-km · passenger/km · train/km · kW and kW/h or electric traction used · etc.	- One part is variable with use, and one part is fixed in advance in relation to expected capacity requirements (usually scheduled train-paths or train path-km) or in relation to an estimation of the fixed costs of the system that have to be covered.
	- Can eventually be weighted by: · speed · axle loadings · types of rolling stock · specific route (including the geometry requirements of the route) · time of day · freight commodity · etc.	- The "fixed" component can be weighted by factors such as: · path quality · scheduled speed · particular line · time of day · etc.
	- Might be most appropriate for a relatively simple network, with few users and where traffic is not approaching network capacity (Norway, for example).	- Most of the fixed component factors tend to be passenger service-driven (particularly by commuter traffic) rather than freight-related (most freight users can adjust their usage to avoid peak time use and thus do not have to burden capacity).
Advantages	- Easier to implement than two-part systems.	- Potentially more efficient in complex, mixed-use networks where more than marginal cost has to be charged.
	- Less costly to implement than two-part systems.	- If used as part of a long run contract may actually improve incentives by reflecting the long run costs of the incremental capacity requirements of a particular user.
	- Probably more effective in collecting marginal (direct) costs.	- May be less distorting in their effects on train operators' decisions that a mark up on the variable charge.
Disadvantages	- More distorting in collecting allocated shares of fixed costs.	- Can, depending on the size of the fixed component of the charges, engender discrimination between various sizes or classes of users. This is particularly the case where the fixed component of the charge is a pure access charge, unrelated to planned use of the system, or where there are large quantity discounts.
	- May not give effective signals to encourage the financing of added capacity.	- Can act as a burden on international freight services if the fixed component of the charge is large.

	Linear tariffs	**Two-part tariffs**
	- If used to collect fixed costs they may no longer give the right signals to use existing capacity to the full.	- Inevitably make the goal of international competitition more difficult to achieve, since the existence of a two-part charge in one country adjoining a country with simple charges inherently creates a type of “seam” that retards international flows.

Ramsey pricing. Third degree of price discrimination

In reality, all operators offer different services (for example, conventional long distance services, high speed services, regional services, etc.), valued by users in a different way. In these cases, the economic theory determines that charges for recovering fixed costs should be different depending on the final service, i.e. a price discrimination charging should be introduced.

FIGURE 1.11 RAMSEY PRICING
Source: Adapted from Toner et al (2008)

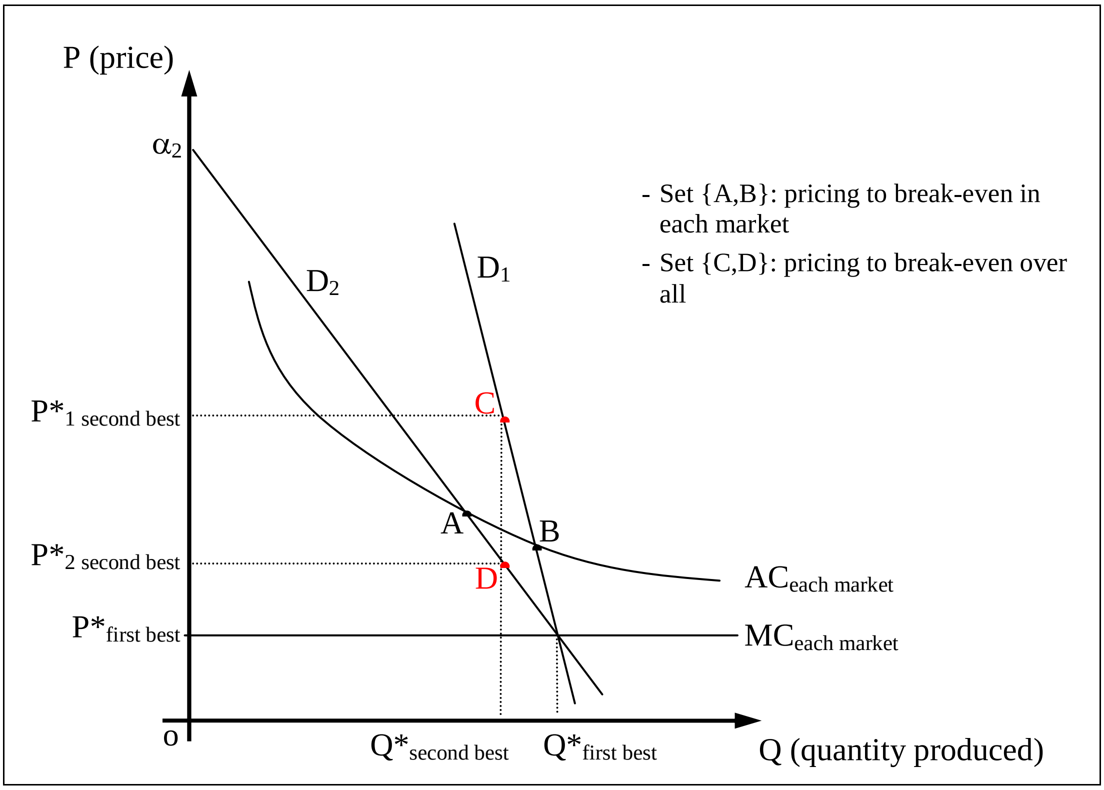


Figure 1.11 shows how costs could be recovered in the case of two different final services. On the one hand, one could charge according to value A (intersection between the demand curve of market 2 and the average cost) and B (intersection between the demand curve of market 1 and the average cost), breaking-even in each market (first degree of price discrimination). On the other hand, one could charge according to values C

and D, breaking-even over all. In the latter case, which corresponds to Ramsey pricing, the profits from market 1 are used to cover some of the costs of market 2, and the social surplus, in welfare terms, is bigger. Therefore, Ramsey pricing allows minimising the loss of efficiency associated with departure from marginal cost pricing and allows the IM to recover its costs, maximising social welfare under State budget constraints. All this by considering that railway infrastructure is a natural multi-product monopoly and assuming independent demands –cross-elasticities equal to zero between the different products– and that there are no externalities (one example would be the charging of one infrastructure segment, not congested, to different operators that operate in different markets –for example, passengers and freight–).

Mathematically, the social welfare maximisation problem under State budget constraints can be presented as follows:

$$SW_i = TR_i + CS_i - TC_i \tag{f. 1.18}$$

where:

$$TR_i = \int_{p_i}^{\alpha_i} f_i(z)dz \quad \text{where } p_i \text{ is the price of the market } i \tag{f. 1.19}$$

$$CS_i = p_i \cdot x_i \quad \text{where } x_i \text{ is the demand of market } i \ (x_i = f_i(p_i)) \tag{f. 1.20}$$

$$TC_i = c_i(x_i) \quad \text{where } c_i \text{ is the cost or market i} \tag{f. 1.21}$$

under the condition that the net revenue (or profit) of the company must exceed some value Π:

$$p_i \cdot x_i - c_i(x_i) \geq \Pi \tag{f. 1.22}$$

where Π corresponds to the quantity of benefit sought or authorised deficit.

The solution to equation f. 1.18 under the constraint f. 1.22 “leads to differentiated prices, according to the demand (...), that distribute all attributable costs, fixed and common, between their services on the basis of the values that those services have for the consumers” (Pietrantonio et al, 2004). Specifically, it establishes that the proportionate deviation of price above marginal cost in each market segment should be inversely proportional to the respective price elasticity, so that when fixing the mark ups, the users most insensible to variations in the price should be those paying higher prices, since this measure will hardly affect their consumption levels:

$$\frac{p_i - MC_i}{p_i} = \frac{\lambda}{1+\lambda} \cdot \frac{1}{\varepsilon_i} \qquad \text{(f. 1.23)}$$

where:

- p_i corresponds to the value of the charge
- $MC_i = \frac{dc_i}{dx_i}$ is the marginal cost
- λ is the Lagrange multiplier of the budgetary constraint Π. It indicates how much would the social benefit increase if Π (amount of benefit sought or authorised deficit, i.e. difference between benefit and cost) would be reduced by one unit, that is, it corresponds to the marginal cost of oportunity of using public subsidies that could be spent elsewhere. λ is equal to zero if prices equal marginal costs and tends to the infinity if benefits are maximised. To give an example, a value of λ=0,3 implies that benefits should be 1,3 times higher than costs.
- ε corresponds to the price elasticity of market *i* demand (its value is negative), defined as the change in demand caused by a 1% change in price.

Generally it is possible to identify different market segments (different values of elasticity) according to:

- *The broad category of train*: passengers train (intercity, suburban, regional) and freight train (container, bulk, general merchandise). In the case of transport infrastructures, passengers demand is less elastic than freight demand. Therefore, Ramsey pricing implies that prices in passenger transport should be higher than those of freight transport (CE, 1997).

- *The location*: the demand of an infrastructure that links two cities with a big economic weight is less elastic than the one registered in an infrastructure that links secondary cities.

- *The time of the day/week/year*: For example, the elasticity of a passenger train is lower at peak hours than at off-peak hours, because generally the passengers that use the train at peak periods do it for obliged mobility reasons. This explains why higher charges can be set at peak periods for passenger trains runs.

On the basis of expression f. 1.23, Crozet (2007) proposes calculating the level of optimal mark up above marginal cost according to the expression:

$$a = \frac{C_i + \frac{\alpha}{\varepsilon} \cdot C_s}{1 - \frac{\alpha}{\varepsilon}} \qquad \text{(f. 1.24)}$$

where:

- a is the level of infrastructure charge with an optimal mark up above marginal cost
- C_i is the marginal infrastructure cost
- C_s is the marginal train service cost
- $C_i + C_s = MC$ is the overall marginal cost
- $\alpha = \frac{\lambda}{1+\lambda}$ is a parameter reflecting the cost opportunity of public funds λ
- ε is the price elasticity of traffic expressed in absolute value

α/ε being the key ratio for determining the optimal value of the mark up above marginal cost.

The application of Ramsey pricing is allowed by Directive 2001/14/EC, as presented in section 1.4. Compared to fully distributed average cost pricing, Ramsey pricing allows establishing prices in an economically efficient way, combining cost and demand factors in an optimal way (Pietrantonio et al, 2004). As a result of that, lower prices can be obtained for operators in general.

The main inconvenients for its application are the fact that its implementation requires a thorough knowledge of the market (operator's costs and demand elasticies of final users, information of the services offered) that is not always easy to obtain, since this information is strategic for the operators (and they are unwilling to make it public). Therefore it is especially difficult to apply in a vertically separated structure (OECD, 1999).

1.3.2.4. Remarks on the different pricing principles

In **table 1.3** the main characteristics of the four pricing principles applied in the railway sector are presented. Even if these pricing principles differ on their philosophical basis and their application, some of them have to face common difficulties, in particular the calculation of marginal and social costs and the evaluation of the impact of the difference between charges and marginal cost on the users.

These difficulties have led to the appearance of detractors of the adoption of marginal cost pricing. Specifically, Rothengatter (2003) criticises the adoption of the marginal cost pricing principle arguying that its determination is complex; it ignores the dynamic effects including investment decisions and technological choice; it also ignores financial and institutional aspects, and the existence of price distorsion in other parts of the economy; in addition, the implementation of social marginal cost tariffs can bring significant administrative costs, which are not always compensated by the benefits it generates. According to Nash (2003), "considerations such as budget constraints, equity, institutional issues, simplicity and price distortions elsewhere in the economy lead to a need to depart from pure marginal social cost pricing but do not change the position that the measurement of marginal social cost is the correct starting point in the development of any efficient pricing policy".

TABLE 1.3 MAIN CHARACTERISTICS OF THE PRICING PRINCIPLES APPLIED IN THE RAILWAY SECTOR

Method	Acronym	Philosophy	Characteristics
(Social) marginal cost pricing	(S)MC	The State covers the difference between the marginal cost and the financial cost.	- Consists in allocating to the users the variable costs related with a particular use. Recomended by the European Union. - The one that, in principle, maximises the degree of efficiency of the use of the infrastructures. - The one that charges more the State budget.
Marginal cost pricing with mark ups above the marginal cost	MC+	Tries to reduce (or eliminate) State intervention and the difference between marginal cost and financial cost.	- If correctly applied, could optimise the equilibrium between the search for efficiency and the budgetary constraints, perfectly allowing to reach the objectives assigned to the method FC-.
Full cost recovery pricing after State subsidies	FC-	Charges fixed at levels that allow recovering the difference between State intervention and the financial cost.	- Protects the IM's financial balance, but incites it to correct the malfunction of its infrastruture services offer to a lesser extent. - Can give rise to inefficiencies in the use of infrastructures. - All the costs that are not directly funded by the State must be distributed amongst infrastructure users in an efficient and equitative way.
Full cost recovery pricing	FC	Charges fixed at levels that allow recovering the financial cost.	- Applied in several Eastern European countries: Estonia, Hungary, Latvia, Poland, Romania, Slovenia.

The most appropriate pricing principle in each railway network will depend on each country's specific circumstances (not all pricing principles allow reaching all the strategic objectives of the charge for the use of the infrastructure presented in section 1.2.2 at the same time – see **table 1.4**). For example, as introduced in section 1.3.3.3, the full cost recovery principle is convenient for freight railway transport in the Baltic States, while in other countries, where railways are at a disadvantage with regard to road transport, it is not convenient if one aims at promoting railways usage.

TABLE 1.4 ACHIEVABLE OBJECTIVES BY THE DIFFERENT PRICING METHODOLOGIES

Methodologies	**Objectives**				
	Better use of capacities	**To direct investment options**	**Productivity improvement**	**Reduction of the need to turn to public funds**	**Fostering a rational and efficient use of the infrastruct.**
MC :					
SRMC	✓	x	x	x	x
LRMC		✓			x
SMC	✓	x	x	x	x
MC+:					
Ramsey		x	✓	✓	
Two-part	x		✓		x
Average costs (FC, FC-)	x		x	✓	x

Remarks:
✓ : Achievable objectives
x : Non-achievable objectives
Blank: No data available

According to Arduin et al. (2002), charge setting should be determined by the global railway project economic profitability. Consequently, for:

- A *global positive and high economic profitability*, the full infrastructure cost recovery principle can be introduced, distributing the project's benefits among railway undertakings.

TABLE 1.5 RAILWAY INFRASTRUCTURE ACCESS PRICING REGIMES BY RAIL USER TYPE
Source: CEMT (2005).

Type of service	Pure SMC	MC+	FC-	FC contract with sponsor (if any)*
Suburban				High requirement for scheduled slots, relatively low speed. Limited response to price signals, high public support.
High speed rail franchise			Use of two-part tariff for operations on conventional lines	Slots all scheduled, rigid quality requirements, number of competing oprators limited
Conventional inter-city passenger and HSR:				
With competition in the railway market		High capacity requirements. Two-part contracts appropriate, but fixed component should be minimised		
Without competition (or with competition for the market [(i)])			High capacity schedule requirements. Suitable for two-part contracts	
Freight	Low schedule and track quality requirements. High response to price signals. Use either SMC or MC+ simple tariff with minimum mark ups. Mark ups (if any) for freight in domestic, import-export and transit traffic movement should be uniform.			

Remarks:

* Full cost recovery contract with the financial public authority.
(i) Competition for the market: it is the one that takes place between the different transport markets.

- A *global low economic profitability* (case in which railway operation is enough to pay investments, the operation and railway undertaking's maintenance), the marginal cost pricing principle can be applied under the condition that the global level of the charge does not affect RU's profitability.

- A *global low economic profitability* (case in which railway operation is not enough for paying investments, operation and RU's maintenance), the marginal cost

> pricing principle can be applied in all cases but a State or community subsidy will be needed not only for infrastructure investments but also for RU’s investments.

On the other hand, theoretic studies carried out on occasion of the introduction of the charges for the use of railway infrastructure in Europe propose, as presented in Baritaud et al. (2000), either a social marginal cost pricing (UIC/CER, 1998) or a Ramsey pricing, which allows covering the fixed costs not covered by State subsidies (NERA et al, 1998), or even the integration of external effects corrections.

CEMT (2005) has also expressed its opinion on the subject (see **table 1.5**). Its standpoint is that railway infrastructure access pricing regimes should be determined according to the rail users type. As it can be seen in **table 1.5**, high performance railway services should be charged (at least in a close future) on the basis of marginal cost plus mark ups, considering that European legislation established that in 2010 passengers’ railway market should be opened to competition.

1.4. CHARGE FOR THE USE OF RAIL INFRASTRUCTURE IN THE EU

A charge for the use of rail infrastructure started to be introduced in a generalised way in the European Union countries as a result of the First Railway Package implementation.

The legislative framework that regulates and defines the charge for the use of railway infrastructure in the European Union countries is presented below, as well as an estimation of the order of magnitude of the infrastructure charge based on the principles established by the European directives.

1.4.1. Legislative framework

The railway pricing structure at the European level is mainly defined by Directive 2001/14/EC[19] relative to, amongst other aspects, the levying of charges for the use of railway infrastructure, which widely complements the first definitions of the charging system for the use of railway infrastructure published in Directives 91/440/CEE[20] and 95/19/CE[21] of the first reforms stage.

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[19] Directive 2001/14/EC of the European Parliament and of the Council of 26 February 2001 on the allocation of railway infrastructure capacity and the levying of charges for the use of railway infrastructure and safety certification.

[20] Council Directive 91/440/EEC of 29 July 1991 on the development of the Community's railways, amended by Directive 2001/12/EC of the European Parliament and of the Council of 26 February 2001.

[21] Council Directive 95/19/EC of 19 June 1995 on the allocation of railway infrastructure capacity and the charging of infrastructure fees.

1.4.1.1. Directive 91/440/EEC

Directive 91/440/EEC initiated the charge definition legislative framework at European level, with a series of considerations on the pricing of railway infrastructures (see **table 1.6**) and several action measures (see **table 1.7**) grouped into section III (“Separation between infrastructure management and transport operations”).

TABLE 1.6 DIRECTIVE 91/440/EEC CONSIDERATIONS OR OBJECTIVES WITH REGARD TO THE RAILWAY INFRASTRUCTURES PRICING
Source: Author’s elaboration with data from Directive 91/440/EEC (CE, 1991).

Nº	Consideration	Objective
Recital clause 6A	“(...) Member States shall (...) lay down rules providing for the payment by railway undertakings and their groupings for the use of railway infrastructure (...)”.	Setting of rules for the payment of user fees
Recital clause 6B	“(...) in the absence of common rules on allocation of infrastructure costs, Member States shall (...) consult the infrastructure managers (...)”.	Interaction States-IM
Recital clause 6C	“(...) such payments must comply with the principle of non-discrimination between railway undertakings”.	Non-discriminatory charge

TABLE 1.7 ACTION MEASURES ESTABLISHED BY DIRECTIVE 91/440/EEC
Source: Author’s elaboration with data from Directive 91/440/EEC (CE, 1991).

Nº	Consideration	Requirement
Article 8.1	“The manager of the infrastructure shall charge a fee for the use of the railway infrastructure for which he is responsible, payable by railway undertakings and international groupings using that infrastructure (...)”.	Establishment of a fee for the use of railway infrastructure
Article 8.2	“(...) After consulting the manager, Member States shall lay down the rules for determining this fee (...)”.	Determination of the charge at a national level
Article 8.3	“The user fee (...) shall be calculated in such a way as to avoid any discrimination between railway undertakings (...)”.	Non discriminatory charge
Article 8.4	“The user fee (...) may in particular take into account the mileage, the composition of the train and any specific requirements in terms of such factors as speed, axle load and the degree or period of utilisation of the infrastructure”.	Possible parameters to be used when calculating the charge

The action measures defined by Directive 91/440/EEC established the obligation of introducing a charge for the use of railway infrastructure at national level (for the EU member states). The directive established that the user fee should be "calculated in such a way as to avoid any discrimination between railway undertakings" and stipulated that, although it is not compulsory, user fees should be calculated on the basis of parameters such as mileage, speed, axle load, time period, etc. Each Memeber State would be responsible for the selection of the parameters to be used to calculate the user fee.

1.4.1.2. Directive 95/19/EC

In 1995, Directive 95/19/EC stressed that the nature of the charge must be non-discriminatory. To this consideration, it added the need for adopting common rules concerning the charging of infrastructure fees, which should be, at the same time, non-discriminatory in a same market, as well as the need for adopting a transparent procedure for charge setting (see **table 1.8**).

TABLE 1.8 DIRECTIVE 95/19/EC CONSIDERATIONS OR OBJECTIVES WITH REGARD TO THE RAILWAY INFRASTRUCTURES PRICING

Source: Author's elaboration with data from Directive 95/19/EC (CE, 1995).

Nº	Consideration	Objective
Recital clause 4A	"(...) it is appropriate to establish a system for (...) the charging of infrastructure fees which is uniform throughout the Community".	Uniform system throughout the EU
Recital clause 4B	"(...) it is appropriate to establish a system for (...) the charging of infrastructure fees which is non-discriminatory (...).	Non-discrimintory charge
Recital clause 10	"The accounts of the infrastructure manager should be in balance so that infrastructure expenditure can be covered".	Recovery of expenditures by the IM
Recital clause 11	"It is necessary to define non-discriminatory rules as regards the charging of infrastructure fees in the same market".	Non-discriminatory fees in a same market
Recital clause 12A	"(...) general concern for transparency and non-discrimination (...)".	Transparency and non-discrimination
Recital clause 12B	"(...) common rules should be adopted concerning the procedures for (...) the charging of infrastructure fees".	Common rules for the charging of infrastructure fees

On the basis of these considerations, the directive lays down, in its section III ("Charging of infrastructure fees"), action measures that oblige infrastructure managers to balance incomes and expenditures under normal business conditions, and to charge non-discriminatory fees fixed by Member States according to the nature of the service, the time of the service, the market situation and the type and degree of wear and tear of the infrastructure (see **table 1.9**).

TABLE 1.9 ACTION MEASURES ESTABLISHED BY DIRECTIVE 95/19/EC
Source: Author's elaboration with data from Directive 95/19/EC (CE, 1995).

Nº	Consideration	Requirement
Article 6.1	"The accounts of an infrastructure manager shall, under normal business conditions over a reasonable time period, at least balance income from infrastructure fees plus State contributions on the one hand and infrastructure expenditure on the other".	Balance of IM's accounts
Article 7A	"There shall be no discrimination in the charging for services of an equivalent nature in the same market".	Non-discriminatory fees for different RU
Article 7B	"After consulting the infrastructure manager, Member States shall lay down the rules for determining the infrastructure fees. These rules shall provide the infrastructure manager with the facility to market the available infrastructure capacity efficiently".	Responsible for the rules for determining the infrastructure fees
Article 8.1	"The fees charged by the infrastructure manager shall be fixed according to the nature of the service, the time of the service, the market situation and the type and degree of wear and tear of the infrastructure".	Fees calculation
Article 9.1	"The fees shall be paid to the infrastructure manager(s)".	Fees beneficiary
Article 9.2	"Member States may require the infrastructure manager to provide all the information on the fees necessary to satisfy them so that they are charged on a non-discriminatory basis".	Non-discriminatory fees

1.4.1.3. Directive 2001/14/EC

Even if directives 91/440/EEC and 95/19/EC established the first principles for the infrastructure fees to follow, Directive 2001/14/EC is the one that widely defines the objectives that charges for the use of the infrastructure should fulfill in Member States. All of them have been summarised in **table 1.10**.

Directive 2001/14/EC lays down that charges should be set according to uniform pricing principles and non-discriminatory criteria (see **table 1.10**), and should be published in a "network statement" [22]. With regard to the structure of the charge, the directive proposes a structure in three main parts (see **figure 1.12**):

- Charges for minimum access package and track access to services facilities.
- Charges for supply of services at track access facilities.
- Charges for "additional and ancillary" services.

TABLE 1.10 DIRECTIVE 2001/14/EC CONSIDERATIONS OR OBJECTIVES WITH REGARD TO THE RAILWAY INFRASTRUCTURES PRICING
Source: Adapted from CENIT et al (2007b) according to the provisions of Directive 2001/14/EC (CE, 2001d).

Nº	Consideration	Objective
General objectives		
Recital clause 5	"To ensure transparency and non-discriminatory access to rail infrastructure for all railway undertakings all the necessary information required to use access rights are to be published in a network statement".	Transparency
Recital clause 10	"The revitalisation of European railways (…) requires fair intermodal competition between rail and road, particularly by taking appropriate account of the different external effects (…)".	Fairness (intermodal)
Recital clause 11	"Charging schemes should permit equal and non-discriminatory access for all undertakings and attempt as far as possible to meet the needs of all users and traffic types in a fair and non-discriminatory manner".	Non-discriminatory access
Recital clause 12	"Within the framework set out by Member States charging and capacity-allocation schemes should encourage railway infrastructure managers to optimise the use of their infrastructure".	Incentive to operational efficiency
Recital clause 15	"It is desirable for railway undertakings and the infrastructure manager to be provided with incentives to minimise disruption and improve performance of the network".	Incentive for reliability
Recital clause 16	"Charging (…) schemes should allow for fair competition in the provision of railway services".	Competition oriented approach
Recital clause 17	"It is important to have regard to the business requirements of both applicants and the infrastructure manager".	Business oriented approach

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[22] Directive 2001/14/EC defines the "network statement" as the statement which sets out in detail the general rules, deadlines, procedures and criteria concerning the charging and capacity allocation schemes. It shall also contain such other information as is required to enable application for infrastructure capacity.

Nº	**Consideration**	**Objective**
Recital clause 23	"Different users and types of users will frequently have a different impact on infrastructure capacity and the needs of different services need to be properly balanced".	Differentiation according to specificities
Recital clause 32	"It is important to minimise the distortions of competition which may arise, either between railway infrastructures or between transport modes, from significant differences in charging principles".	Consistency (charging principles)
Recital clause 33	"It is desirable to define those components of the infrastructure service which are essential to enable an operador to provide a service and which should be provided in return for minimum access charges".	Definition of types of charges
Recital clause 34	"Investment in railway infrastructure is desirable and infrastructure charging schemes should provide incentives for infrastructure managers to make appropriate investments where they are economically attractive".	Incentive to appropriate investment
Recital clause 35	"Any carging scheme will send economic signals to users. It is important that those signals to railway undertakings should be consistent and lead them to make rational decisions".	Consistency (investments)
Recital clause 36	"To enable the establishment of appropriate and fair levels of infrastructure charges, infrastructure managers need to record and establish the valuation of their assets and develop a clear understanding of cost factors in the operation of the infrastructure".	Cost relatedness
Recital clause 37	"It is desirable to ensure that account is taken of external costs when making transport decisions".	Sustainability
Recital clause 40	"A railway infrastructure is a natural monopoly. It is therefore necessary to provide infrastructure managers with incentives to reduce costs and manage their infrastructure efficiently".	Incentive to cost efficienty
Specific objectives: Cost categories(i) and cost centres(ii)		
Recital clause 36	"To enable the establishment of appropriate and fair levels of infrastructure charges, infrastructure managers need to record and establish the valuation of their assets and develop a clear understanding of cost factors in the operation of the infrastructure".	Cost relatedness
Specific objectives: Cost of use of assets (wear and tear)		
Recital clause 21	"(…) charging schemes may need to take account of the fact that different components of the rail infrastructure network may have been designed with different principal users in mind".	Differentiation according to specificities

Nº	**Consideration**	**Objective**
Recital clause 38	"It is important to ensure that charges for international traffic are such as to permit rail to meet the needs of the market; consequently infrastructure charging should be set at the cost that is directly incurred as a result of operating the train service".	Cost relatedness
Specific objectives: Mark ups		
Recital clause 39	"(…) it is desirable for any infrastructure charging scheme to enable traffic to use the rail network which can at least pay for the additional cost which it imposes".	Fairness (intramodal)
Specific objectives: Reservation charges		
Recital clause 44	"The allocation of capacity is associated with a cost to the infrastructure manager, payment for which should be required".	Cost relatedness
Specific objectives: Performance regimes		
Recital clause 43	"It is desirable for railway undertakings and the infrastructure manager to be provided with incentives to minimise disruption of the network".	Incentive to operational efficiency
Specific objectives: Congestion and scarcity related charges		
Recital clause 25	"The charging schemes must take acount of the effects of increasing saturation of infrastructure capacity and ultimately the scarcity of capacity".	Consideration of saturation and scarcity
Specific objectives: Environmental charges/subsidies		
Recital clause 37	"It is desirable to ensure that account is taken of external costs when making transport decisions".	Sustainability
Recital clause 38	"It is important to ensure that charges for international trafic are such as to permit rail to meet the needs of the market; consequently infrastructure charging should be set at the cost that is directly incurred as a result of operating the train service".	Cost relatedness
Specific objectives: Discounts		
Recital clause 42a	"Discounts which are allowed to railway undertakings must relate to actual administrative cost savings experienced (...)".	Cost relatedness (discounts)
Recital clause 42b	"(…) discounts may also be used to promote the efficient use of infrastructure".	Incentives for operational efficiency (discounts)

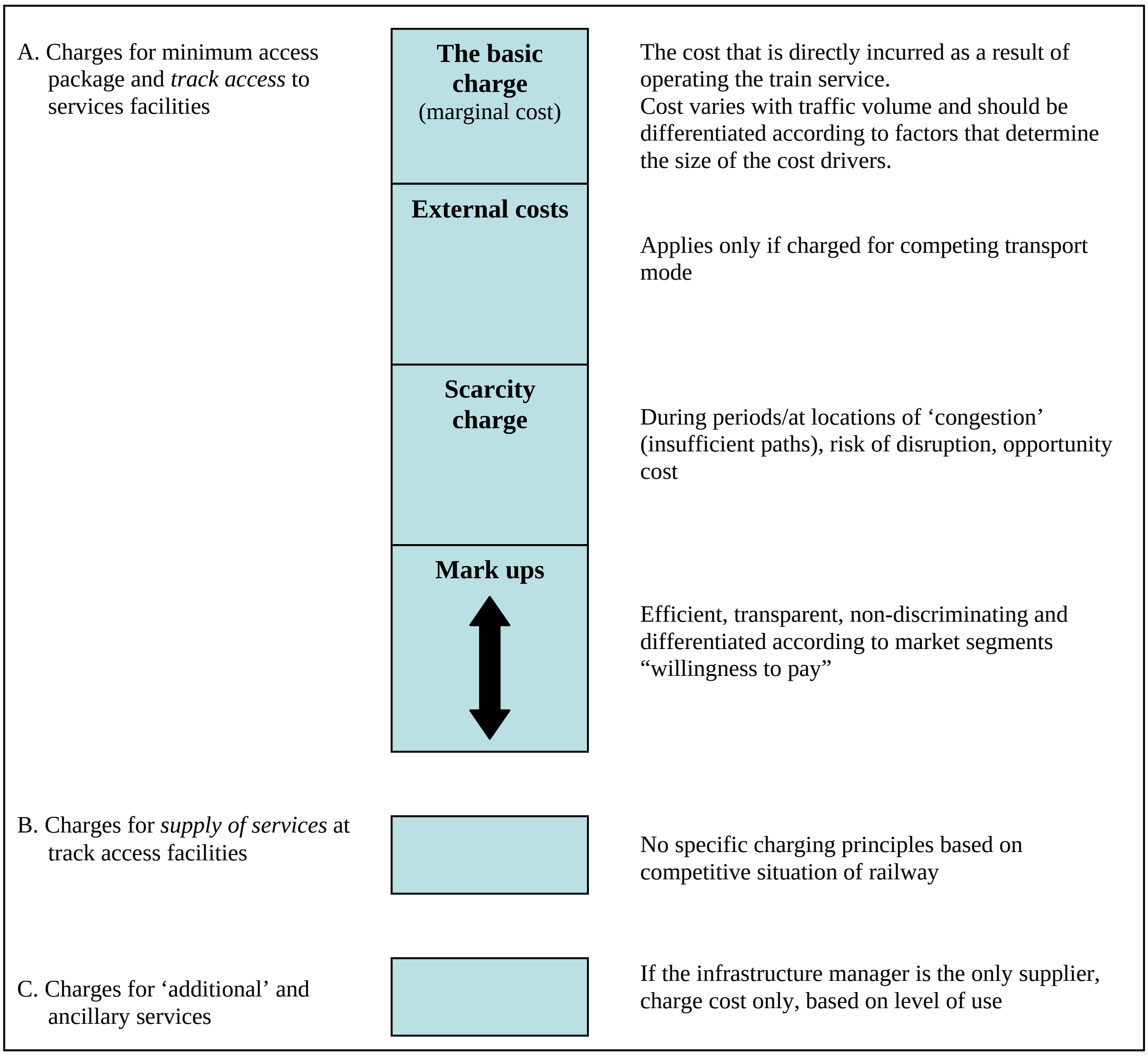
Remarks:

(i) Examples of cost categories (or cost elements) in the railway framework are train planning and operations, electricity, congestion and scarcity, maintenance and renewals, other services, external costs.

(ii) The cost centres are the parts of the companies to which certain costs are attributed. In the railway framework, a cost centre could be, for example, the high peed business unit.

FIGURE 1.12 CHARGING STRUCTURE ACCORDING TO THE PROVISIONS OF DIRECTIVE 2001/14/EC

Source: DG-TREN (2007) according to the provisions of Directive 2001/14/EC.



A. Charges for minimum access package and *track access* to services facilities	**The basic charge** (marginal cost)	The cost that is directly incurred as a result of operating the train service. Cost varies with traffic volume and should be differentiated according to factors that determine the size of the cost drivers.
	External costs	Applies only if charged for competing transport mode
	Scarcity charge	During periods/at locations of ‘congestion’ (insufficient paths), risk of disruption, opportunity cost
	Mark ups	Efficient, transparent, non-discriminating and differentiated according to market segments “willingness to pay”
B. Charges for *supply of services* at track access facilities		No specific charging principles based on competitive situation of railway
C. Charges for ‘additional’ and ancillary services		If the infrastructure manager is the only supplier, charge cost only, based on level of use

The charge for the minimum access package is made up of a **basic charge**, **external costs**, a **scarcity charge** and a series of **mark ups**.

The specific requirements related to the basic charge are described in Article 7 of the directive. Amongst them the marginal cost focus that charges must have is highlighted (see **table 1.11**).

With regard to external costs, the directive allows taking into consideration the environmental effects caused by railway service operation. The directive allows pricing the environmental costs if a comparable pricing for all transport modes competing with railways exists (see **table 1.11**).

TABLE 1.11 ACTION MEASURES ESTABLISHED BY DIRECTIVE 2001/14/EC
Source: Adapted from CENIT et al (2007b) according to the provisions of Directive 2001/14/EC (CE, 2001d).

Nº	Consideration	Requirement
General requirements related to the charging practice		
Article 4.4	"Except where specific arrangements are made under Article 8.2, infrastructure managers shall ensure that the charging scheme in use is based on the same principles over the whole of their network".	Uniformity of charging principles
Article 4.5	"Infrastructure managers shall ensure that the application of the charging scheme results in equivalent and non-discriminatory charges for different railway undertakings that perform services of equivalent nature in a similar part of the market (…)".	Non discriminatory charges for different RU
Article 8.3	"To prevent discrimination, it shall be ensured that any given infrastructure manager's average and marginal charges for equivalent uses of his infrastructure are comparable and that comparable services in the same market segment are subject to the same charges. The infrastructure manager shall show in the network statement that the charging system meets these requirements insofar as this can be done without disclosing confidentail business information".	Equivalent charges for equivalent uses of the infrastructure and comparable services
Specific requirements: Cost of use of assets		
Article 7.3	"(...) the charges for the minimum access package and track access to service facilities shall be set at the cost that is directly incurred as a result of operating the train service".	Marginal cost approach
Article 7.6B	"(...) the relative magnitudes of the infrastructure charges shall be related to the costs attributable to the services".	Relation between charges and costs attributable to services
Specific requirements: Mark ups		
Article 8.1A	"(...) The charging system shall respect the productivity increases achieved by railway undertakings (...)".	Respect to RU productivity increases
Article 8.1B	"(...) the level of charges must not exclude the use of infrastructure by market segments which can pay at least the cost that is directly incurred as a result of operating the railway services, plus a rate of return which the market can bear".	No exclusion of market segments able to pay their marginal cost

Nº	**Consideration**	**Requirement**
Article 8.2	"For specific investment projects (...) the infrastructure manager may set or continue to set higher charges on the basis of the long-term costs of such projects if they increase efficiency and/or cost-effectiveness and could not otherwise be or have been undertaken (...)".	Conditions to levy mark ups for specific investment projects
Specific requirements: Reservation charges		
Article 12	"Infrastructure managers may levy an appropriate charge for capacity that is requested but not used. This charge shall provide incentives for efficient use of capacity (...)".	Incentives for efficient use of capacity
Specific requirements: Performance regimes		
Article 11.1A	"Infrastructure charging systems shall through a performance scheme (...)".	Implementation of a performance scheme
Article 11.1B	"Infrastructure charging schemes shall (...) encourage railway undertakings and the infrastructure manager to minimise disruption and improve the performance of the railway network (...)".	Improvement of operational performance of the network
Article 11.2	"The basic principles of the performance scheme shall apply throughout the network".	Uniformity of the performance scheme
Specific requirements: Congestion and scarcity related charges		
Article 7.6B	"(...) the relative magnitudes of the infrastructure charges shall be related to the costs attributable to the services".	Relation between charges and costs attributable to infrastructure services
Specific requirements: Environmental charges/subsidies		
Article 7.5A	"The infrastructure charge may be modified to take account of the cost of the environmental effects caused by the operation of the train. Such a modification shall be differentiated according to the magnitude of the effect caused (...).	Differentiation according to magnitude
Article 7.5B	"(...) charging environmental costs which results in an increase in the overall revenue accruing to the infrastructure manager shall however be allowed only if such charging is applied at a comparable level to competing modes of transport (...)".	Application to competing transport modes
Article 7.6B	"(...) the relative magnitudes of the infrastructure charges shall be related to the costs attributable to the services".	Relation between charges and costs attributable to infrastructure services

Nº	Consideration	Requirement
Specific requirements: Discounts		
Article 9.2A	“With the exception of paragraph 3 (Article 9.3), discounts shall be limited to the actual saving of the administrative cost to the infrastructure manager (...)”.	Limited to saving on administrative costs
Article 9.2B	“(...) In determining the level of discount, no account may be taken of cost savings already internalised in the charge levied”.	Already internalised cost savings cannot be incorporated
Article 9.3A	“Infrastructure managers may introduce schemes available to all users of the infrastructure (...)”.	Availability to all users
Article 9.3B	“Infrastructure managers may introduce schemes (...) granting time limited discounts (…)”.	Limitation in time
Article 9.3C	“Infrastructure managers may introduce schemes (...) to encourage the development of new rail services, or discounts encouraging the use of considerably underutilised lines”.	Encouragement of new rail services
Article 9.5	“Similar discount schemes shall apply for similar services”.	Similar discounts for similar services

In addition, the directive allows infrastructure managers to include “a charge which reflects the scarcity of capacity of the identifiable segment of the infrastructure during periods of congestion” (Article 7.4). The requirements to be accomplished by these scarcity charges are summarised in **table 1.11**.

The nature of the mark ups, which can be applied by infrastructure mangers to fully recover their costs and for specific investments projects, is defined in Article 8 of the directive (see **table 1.11**).

In addition to these components, Directive 2001/14/EC allows infrastructure managers to “levy an appropriate charge for capacity that is requested but not used” (Article 12). It also allows the application of time limited discounts to encourage the development of new rail services or the use of considerably underutilised lines (see **table 1.11**).

In short, the basic charge, set according to the marginal cost principle[23], can be modified:

- Upwards, in order to take into account congestion, to favour investments and

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[23] The marginal cost principle implies in this case that “the charges for the minimum access package and track access to service facilities shall be set at the cost that is directly incurred as a result of operating the train service” (Directive 2001/14/EC, Article 7).

improve performance, and to include environmental costs (although only when they are also taken into account in transport modes competing with railways).

- Downwards, in order to encourage new railway services or the use of considerably underutilised lines.

In addition, if the State wishes so and if the market can bear it, charges may even cover full costs.

1.4.2. Estimation of the charge for the use of infrastructure based on short-run social marginal costs and of the optimal mark up for high speed lines

At the European level, the European Commission as well as several countries favour introducing and/or reinforcing cost-based infrastructure charges principle and practice. In this line, and as it has been shown in section 1.3.2, short-run social marginal costs are considered to be the most appropriate as departure point for the price fixing process (Ricci et al, 2006). Consequently, a correct estimation of marginal costs (or cost elements) derived from the railway system is essential to be able to set the charges for the use of infrastructure at levels that allow incentivising both infrastructure provision and trains operation. Nevertheless, in the railway sector no consensus for defining each of the railway marginal cost components exists.

On the following pages the state of the art on railway infrastructure social marginal cost measurement in the European framework is briefly presented. Based on this, two estimations of the order of magnitude of railway charge for high speed railways will be made: one based on social marginal cost charging (first best) and one based on Ramsey pricing, applying optimal mark ups.

1.4.2.1. Estimation and magnitude of social marginal costs for setting charges based on marginal cost: State of the art

In this section the state of the art on the estimation and magnitude of social marginal costs it is presented, mainly based on Sánchez-Borràs et al (2008c). These costs include infrastructure marginal costs, environmental costs, accident costs, and congestion and scarcity costs (IMPRINT-NET 2006).

Infrastructure marginal costs

The analysis of the interaction between operations and infrastructure for pricing aims is very recent, since the analysis of railway costs before the reorganisation of the railway sector was focused on the vertically integrated railway model.

It is currenlty generally accepted that the only infrastructure manager's costs that vary in the short term with the running of trains are maintenance costs[24] (Sánchez-Borràs et al, 2008c) or that, at least, all costs other than wear and tear ones are very low. Therefore, infrastructure marginal costs would correspond to these wear and tear costs (or to maintenance and renewals marginal costs).

In the last years several studies have been carried out trying to estimate the most appropriate level of infrastructure charges in certain countries. Despite of that, there is yet no consensus for defining the railway infrastructure cost components. This can be explained by the fact that, in order to estimate infrastructure costs, it is necessary to understand how the infrastructure use generates costs, i.e. it is necessary to know which are the cost-drivers. This is a complicated task, since in many cases the link between use and cost is multidimensional, in the sense that several costs associated with a particular usage type may exist. This is mainly due to the different definitions of a track standard and to the regime applied by each infrastructure manager, that are at the same time related to the infrastructure investment levels and to the type of runs allowed on it (freight and high speed trains runs, etc.). This translates into the existence of multiple relationships between infrastructure maintenance cost and its use.

Lately several authors and studies have dealt with the subject (Thomas, 2002; Rothengatter, 2003; Peter, 2003; Nash, 2005; Link et al, 2005; Finnish Rail Administration, 2007; Andersson, 2007; GRACE, 2006[25]), but much research can still be done in this field. The state of the art on the infrastructure wear and tear marginal costs estimation carried out by Sánchez-Borràs et al. (2008c) is presented below.

The infrastructure wear and tear marginal costs estimation can be divided into two groups: **top-down approaches** and **bottom-up approaches**.

Top-down approaches use data on infrastructure maintenance and/or renewals costs and estimate the proportion of those costs that vary with traffic. In Europe two methodologies for carrying out such approaches have been implemented:

- *Econometric method*, which estimates an infrastructure total costs function from transversal or temporal data series, from which it is possible to obtain the marginal

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[24] Other cost elements of the IM are, for instance, train planning and signalling.

[25] The GRACE Project (Generalisation of Research on Accounts and Cost Estimation, 2005-2008), directed by DG TREN within the Sixth Framework Programme of Research and Technological Development, includes studies for measuring wear and tear, congestion, accidents and environmental impacts marginal costs, mainly focused on road and rail transport (more information on the project is available at: www.grace-eu.org). The project CATRIN, currently under development, should contribute with new results on wear and tear marginal costs.

cost considering the total cost first derivative with regard to the number of gross tonnes per kilometre. Consequently, this method considers that total expenditure can be explained by different variables, amongst which we can find the transport activity product. The main current disadvantage of the econometric method is that for estimations to be reliable it is necessary to have a data sample with enough data and quality.

- *Cost allocation method*, which allocates parts of the total cost to cost activities (registered in the available accounting information) and afterwards uses engineering opinions to determine cost variability depending on traffic. The main disadvantages of this method are the fact that it gives a measure of variable average costs that can differ from true marginal costs and that results strongly depend on the experts' opinion. This method is considered to be a pragmatic alternative to the estimation of a cost function with econometric methods.

On the other hand, **bottom-up approaches** are based on engineering models for determining the probable wear and tear caused by running an extra service. Specifically, the total expense is disaggregated in subcategories and for each one a specific analysis is carried out in order to determine the variable part of the expense in each category. That is, the engineering method allocates total variable costs to the different trains that run on the infrastructure, by means of relations between costs and level of use. Theoretically, this method should give a precise measure of the wear and tear marginal cost because, as opposed to top-down approaches, it is based on maintenance and renewal needs rather than on historical activity, which can be distorted, for instance, by budgetary constraints. In spite of that, real-world engineering models may depend on weak suppositions and not cover all wear and tear costs aspects. Therefore in railway transport the application of bottom-up approaches is often only used to allocate variable costs determined with top-down models to different vehicle types (Booz Allen Hamilton et al, 2005).

According to Imprint-Net (2006), econometric and engineering methods for measuring infrastructure marginal costs can complement each other. Indeed, econometric methods can provide evidence on total and marginal costs elasticities, while engineering methods can provide evidence on marginal cost differentiation according to relevant parameters.

Given the difficulties in establishing a relation between infrastructure use and cost, as well as the existence of divergences in the cost estimation and its definition[26], infrastructure

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[26] Maintenance and renewal costs can have different definitions in various countries (Quinet, 2008). It is for this reason that it may be misleading to compare the costs of each of these two categories from one country to another if the definitions are not the same. Quinet (2008) defines both costs for the French railway case. On the one hand, inspection and detection, correction maintenance (which aims at curing the damages that

costs differ unavoidably from one administration to another. At a European level, differences between marginal costs levels vary with a relatively high factor. Nevertheless, econometric studies carried out to this date (see **table 1.12**) give, as a general rule, wear and tear marginal cost estimations lower than 1€/1000 gross tonne-kilometre. The results found by Crozet (2007) for the French network are to be highlighted as exceptions to this tendency: they are significantly higher than the unit (approximately 4,65 €/1000 gross tonne-kilometre for high speed runs, considering a TGV-Duplex train, which weights 430 gross tonnes). These results would therefore be more in line with the results of cost allocation found for the British case.

TABLE 1.12 RESULTS OF EMPIRICAL STUDIES ON MARGINAL RAIL INFRASTRUCTURE COSTS

Source: Sánchez-Borràs et al (2008c) with data from EC (2006), Wheat (2007), Lindberg (2006), Wheat et al (2008)

Study	Study type	Country	Usage elasticity(1)	Scaled elasticity (% maintenance costs) (2)	Average MC (€/1000 gross tonne-km) (3)
Maintenance only					
Andersson (2006a)	Econometric	Sweden	0,204*	0,204 (100%)	0,35
Wheat and Smith (2008) (model IV)	Econometric	Great Britain	0,239*	0,108 (45%)	1,25
Wheat and Smith (2008) (model VI)	Econometric	Great Britain	0,378	0,17 (45%)	1,78
Marti and Neuenschwander (2006) Model Type 1	Econometric	Switzerland	0,200	Not reported	0,45
Marti and Neuenschwander (2006) ModeloType 2	Econometric	Switzerland	0,285	Not reported	0,38
Johansson and Nilsson (2002)	Econometric	Sweden	0,1691*	Not reported	0,143
Johansson and Nilsson (2002)	Econometric	Finland	0,167*	Not reported	0,27
Tervonen and Idstrom (2004)	Econometric	Finland	0.,133-0,175	0,073-0,096 (55%)	0,22
Munduch et al (2002)	Econometric	Austria	0,27	Not reported	0,55
Gaudry and Quinet (2003)	Econometric	France	0,37*	Not reported	Not reported
Booz Allen and Hamilton (2005)	**Cost allocation**	Great Britain	0.,28 for track maintenance	0,14 (50%)	1,77
Maintenance and renewals					
Andersson (2006a)	Econometric	Sweden	0,302*	(100%)	0,79

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the inspection has shown to be both important and local) and prevention maintenance (which aims regularly at correcting small defaults and divergences on a regular and systematic basis) are considered to be maintenance operations. On the other hand, renewals operations are individualised and planned three years in advance.

Study	Study type	Country	Usage elasticity$^{(1)}$	Scaled elasticity (% maintenance costs) $^{(2)}$	Average MC (€/1000 gross tonne-km) $^{(3)}$
Crozet (2007)**	Econometric	France	Not reported	Not reported	High speed: 2,1-2,4 Suburban: 2,9-3,1 Inter-urban: 2,0-3,6 €/train-km
Marti and Neuenschwander (2006)	Econometric	Switzerland	0,265	Not reported	0,97
Tervonen and Idstrom (2004)	Econometric	Finland	0,267-0,291	0,150-0,160 (55%)	Not reported
Booz Allen and Hamilton (2005)	**Cost allocation**	Great Britain	0,19	Not reported	4,99
Renewals only					
Andersson (2006b)	Duration	Sweden	Not reported	-	0,32 passenger 0,14 freight
Booz Allen and Hamilton (2005)	**Cost allocation**	Great Britain	0,19 (renewals as a whole); 0,45 for track renewals	Not reported	3,45
Operations only					
Andersson (2006a)	Econometric	Sweden	0,324	-	0,61 per train-km

Remarks:

- For class 390 pendolino, ORR recommends charges of around 14p per vehicle mile. This amounts to roughly 1 euro per train-km or 2 euros per 1000 gross tonne-km.
- The studies highlighted are the latest econometric studies for maintenance and maintenance and renewal costs for each country.

(1) The usage elasticity corresponds to the elasticity of cost with respect to usage.

(2) The scaled elasticity is constructed by multiplying the average usage elasticity by the proportion of total maintenance (or maintenance and renewal) cost considered in the study. The scaled elasticity, defined by Link et al (2007), gives a more comparable figure between studies because, provided the elements of cost excluded from each analysis do not vary with usage, the scaled elasticities give the elasticity of total maintenance cost with respect to usage.

(3) 2005/06 prices

(*) average elasticity

(**) Average marginal cost estimated from Gaudry and Quinet (2003)

Environmental marginal costs

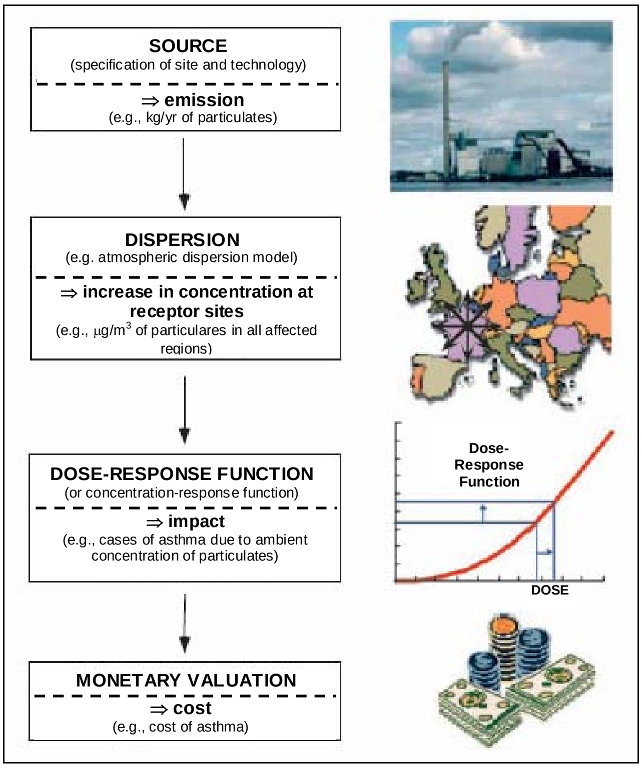
The most significant environmental costs associated with rail are noise, greenhouse gas emissions and air pollutant emissions. Those costs vary considerably with vehicle technology and site (or route) characteristics.

The calculation methods developed to this day for their estimation can be classified, according to their approach, as **damage cost approach** and **avoidance cost approach**, the former being the one most used.

The *Impact Pathway Approach* (IPA), a method developed within the ExternE project series following the damage cost approach, is currently considered to be the most reliable tool for estimating environmental impacts (Bickel et al, 2001).

The *Impact Pathway Approach*, which uses the bottom-up calculation principle for the estimation of environmental costs caused by air pollutant emissions and noise, is structured in four stages (see **figure 1.13**). The first stage is devoted to modelling of transport activity emissions, using data on parameters such as average speed, traffic situation, load, etc., and using emission factors according to the vehicle type (road vehicle, diesel trains, vessels, airplanes). The second stage is dedicated to the dispersion modelling, focusing on pollutants concentration and settling. The third stage links changes in air pollutant concentrations to changes in human health, materials corrosion, etc., applying dose-response (or concentration-response) functions. Finally, it carries out the economic valuation of the injuries quantified with the individual preferences valuation using market prices when possible or revealed preference approaches or contingent valuation surveys when not.

FIGURE 1.13 STRUCTURE OF THE IMPACT PATHWAY APPROACH FOR THE ESTIMATION OF ENVIRONMENTAL MARGINAL COSTS
Source: Bickel et al (2005)



The IPA has some uncertainties and gaps. According to Bickel et al (2001), the most important ones are those linked to the impact valuation, more than to the emissions quantification. According to CE Delft (2008), the main problem of the IPA is the lack of information on the dose-response function for measuring the damage caused.

The external cost estimates from rail transport vary somewhat (Sánchez-Borràs et al, 2008c) as this depends on a number of factors including average occupancy rates, type of traction, maximum and average speeds, stop spacing and the unit value of externalities.

The studies carried until now show, in any case, environmental externalities for rail transport to be low: Sansom et al (1998) suggest a figure of 0,6 €/train-km for British intercity trains, whereas Bickel et al (2005) give figures for different countries covering air pollution, noise and global warming ranging from 0,61 to 1,33 €/train-km.

Accident marginal costs

Transport accidents have negative effects both on the victim of the accident and on society as a whole. However, only those accident costs (be them material –medical and hospital costs, administrative costs, net lost production and congestion caused, property damage– or non material –opportunity cost for the society bearing permanently disabled citizens or loss of human lifes and the suffering cost and victims' and their relatives' pain cost–) caused by the running of additional trains and that are not directly born (or born through insurance) by the train operator that suffers the accident are considered as marginal external accident costs.

Some of the external accident costs are easily quantifiable (direct costs), such as for instance medical and property damage costs, while others are more difficult to quantify (indirect costs). Within the latter group, we can find the increase in accident risk for extra trains running on the network and for road users in level crossings, as well as any cost element (such as for instance medical expenses, social and family pain, grief and suffering for injuries and death, etc.) born by third parties without an appropriate compensation.

Among the existing methodologies for quantifying indirect accident marginal costs, the most commonly used methods are survey-based Contingent Valuation Methods (CVM) that allow determining the users' willingness to pay (WTP) in order to reduce death and injury risks. However, there is very little evidence on these values for rail and therefore it is generally assumed that "given the low accident risk, and the fact that railway companies are responsible for their own insurance" (i.e. costs are mainly directly borne or through insurance by railway operators), "it seems unlikely that the external accident costs are very large" (Nash et al, 2004).

Congestion and scarcity marginal costs

Congestion marginal costs seek to reflect the economic costs of the consequences of changes in traffic levels on congestion on the network[27] (Gibson et al, 2002), while **scarcity costs** are those costs that arise where the operation of a train service prevents another one from operating, or requires it to take an inferior path (Abrantes et al, 2008). Therefore, congestion and scarcity costs are only relevant when lines are operated at levels close to capacity.

Congestion marginal costs will be external only if the train that suffers the delay belongs to another operator. CE Delft (2008) presents external congestion marginal costs estimations. The values given are those proposed by UNITE D7[28] and have been estimated to be around 0,20 €/train-km at peak periods for the British and Swiss cases[29].

With regard to scarcity marginal costs estimation, Abrantes et al (2008) highlight the difficulty in developing a general methodology for their estimation. This is due to the fact that a network might be used to run many possible combinations of services, which makes it difficult to uniquely determine its capacity and therefore the opportunity cost of a given service.

The GRACE project (GRACE, 2006) did some research in scarcity costs, but the total level of scarcity values were treated as confidential information and therefore remain unpublished.

1.4.2.2. Estimation of the charges for the use of the infrastructure based on short-run social marginal costs for high speed lines

As seen in section 1.4.2.1, short-run social marginal costs include maintenance and renewals marginal costs, and environmental, accident and congestion and scarcity external marginal costs[30].

The estimation of the charge for the use of infrastructure based on short-run social marginal costs for high speed lines implemented to date in European countries requires to take into consideration not only the cost estimations presented in the preceding section but

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[27] It is assumed that a railway line is congested when, given high rail infrastructure usage levels, an additional train on the track gives rise to additional delays to other trains, reducing the system capacity to recover the delays.

[28] “UNIfication of accounts and marginal costs for Transport Efficiency” is a project within the Fifth European Union Framework Programme (1998-2002).

[29] However, it has to be highlighted that the value for the Swiss case should be mostly internal, since the opening to competition in the Swiss network had not yet taken place when the estimation was made.

[30] The quantification of environmental, accident, and congestion and scarcity internal marginal costs is not appropriate, since they are already internalised by the operador that generates them.

also the aspects presented in this one.

With regard to environmental costs, their internalisation is still a pending issue in the transport sector, and even more so in the passenger transport sector. To date, only the Finish, Latvian and Polish railway pricing systems internalise them, according to data published by CEMT (2005)[31]. In fact, Directive 2001/14/EC states that external environmental costs will only be charged by infrastructure pricing systems if they are also charged in the transport modes that compete with railways. Therefore environmental costs will not be taken into account in the estimation of the charge.

Marginal accident costs will as well be rejected for the purpose of this analysis, because according to what has been presented in the preceding section, they can be considered negligible in the railway transport.

Concerning marginal congestion and scarcity costs, Abrantes et al. (2008) affirm that "where congestion or scarcity costs are imposed on the same firm that causes the costs, they are already internalised. Thus they are only really important in pricing when there is a lot of competition between different firms (or between parts of the same firm that act independently, such as passenger and freight sectors of a traditional railway company)". It is for these reasons that for new high speed lines, congestion and scarcity costs could be considered negligible in most cases. On the one hand, high speed lines are mainly used solely by passenger services (except in Germany, where some high speed lines are used both by passenger and freight services). On the other hand, competition between different firms does not yet exist[32] and, consequently, there is only one operator per route and the possible congestion and scarcity costs are already internalised by the operator causing them. Furthermore, while in very few high speed lines, such as the Paris-Lyon line, track occupancy at peak hours could be considered especially high and could, perhaps, come close to track capacity, in most cases new high speed lines capacity is much higher than the registered traffic[33]. Where there is no shortage of capacity, i.e. where it is not expected to be a problem within the planning period, Nash et al (2004) affirm that the most efficient approach to charge a section is to apply a nil charge. As a result of all these arguments, marginal congestion and scarcity costs will not be considered for the quantification of the

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[31] In Germany, noise external costs are only partially internalised by the charges for the use of the infrastructure.

[32] Directive 2001/14/EC stipulates that the opening of the railway market for passenger services will take place in 2010.

[33] Studies such as "Etude de modélisation du trafic regional sur lignes à grande vitesse – Corridor sud", directed by UIC and carried out by CENIT (CENIT, 2008), and which analyses how to increase new high speed lines usage introducing a new product on new high speed lines, called regional high speed, are an excellent proof of the capacity that new European high speed lines have to bear much more runs than the ones currently registered.

order of magnitude of the charge based on social marginal costs.

TABLE 1.13 ESTIMATION OF THE CHARGE BASED ON MARGINAL COSTS (IN €/TRAIN-KM) FOR PASSENGER TRAINS RUNNING ON CONVENTIONAL AND HIGH SPEED LINES

Marginal cost	**High speed lines**	**Conventional lines**
Infrastructure(1)	2,1 €/train-km(2)	▪ France: ≈ 2 €/train-km for main intercity lines with high traffic (2) ▪ United Kingdom: 2,5 €/train-km(3) ▪ Sweden – Switzerland: 0,4-0,5 €/train-km(4)
Environmental	Great variability	Great variability
Accident	Negligible	Negligible
Congestion	0	≤ 0,20 €/train-km
Scarcity	Already internalised	?
Estimated TOTAL MC		
MC	≈ 2 €/train-km	0,4-2,5 €/train-km (intercity lines: ≈ 2 €/train-km)
SMC	≈ 4 €/train-km	?
ESTIMATED CHARGE(5)	≈ 2 €/train-km	≥ 0,4-2,5 €/train-km (intercity lines: ≈ ≥ 2 €/tren-km)

Remarks:

(1) It includes maintenance and renewals.
(2) Calculated from Crozet (2007), with the average marginal costs estimated by Gaudry et al (2003).
(3) Data for the United Kingdom: taken from Booz Allen and Hamilton (2005), considering that a passenger train weights 500 gross tonnes.
(4) Calculated from Andersson (2006a) and Marti et al (2006) data, considering that a passenger train weights 500 gross tonnes.
(5) Taking into consideration the remarks presented in section 1.4.2.2.

Finally, with regard to marginal maintenance and renewals costs, several authors have estimated them using different approaches, and have obtained significantly different values in some cases (see **table 1.12**). The differences in the estimations could stem from differences in the methodology used (model/function used), differences in the infrastructure (in terms of design and quality) and differences in the sample of data. In the CATRIN[34] project framework, a benchmarking of the different methodologies used by different countries and authors for determining maintenance and renewal marginal costs is being carried out. The results should clarify the origin of the differences in the estimations and provide more precise data on wear and tear marginal costs. Given that the estimations

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[34] CATRIN is a research project to support the European transport policy, specifically to assist in the implementation of transport pricing.

deduced from Crozet (2007) with data from Gaudry et al (2003) are the only ones published hitherto that distinguish by line or service type (the other estimations refer to the whole network, without distinguishing by type of infrastructure), the results published by this author will be the ones considered in this study. Therefore, the value considered for maintenance and renewal marginal costs will be of 2 €/train-km approximately for high speed runs.

Table 1.13 summarises the short-run social marginal costs value and the estimated magnitude of the charge based on social marginal costs for the current charging scenario (no internalisation of environmental marginal costs), for passenger trains running on high speed and conventional lines in Europe, according to the considerations presented before. According to these results, it would not seem appropriate to have a **first best pricing** with charges for the use of the infrastructure above **2 €/train-km for high speed trains** (4 €/train-km if environmental external marginal costs were internalised). For intercity trains running on conventional lines with high traffic, the data published by Crozet (2007) gives values equivalent to the ones found for high speed runs.

1.4.2.3. Estimation of the optimal mark up above social marginal cost for high speed lines

Using formula f. 1.24 proposed by Crozet (2007), in this section the level of optimal mark up above marginal cost is estimated.

For the French case, the cost opportunity of public funds λ is, according to official data, 0,3. Therefore, α = 0,23 (Crozet, 2007)[35]. Given this value and the demand elasticity value for different links, for the French high speed railway network the optimal mark up above marginal cost would range, according to Crozet (2007), between 2 and 3,2 times the marginal cost, for elasticities of -1,50 (Paris-Nice link) and -0,70 (Paris-Lyon link), respectively.

Supposing that the infrastructure usage marginal cost for high speed lines is about 2 €/train-km (see section 1.4.2.2), the charges for the use of the infrastructure applied to high performance runs (high speed lines or main intercity lines with high traffic) should not be higher than 6,4 €/train-km for elasticities $\varepsilon \geq 0{,}70$ (in absolute value) and a cost opportunity of public funds $\lambda \leq 0{,}3$:

$$\text{Charge for the use of the infrastructure} \leq 6{,}4 \text{ €/train-km} \qquad \text{(f. 1.25)}$$
$$(\text{if} \quad MC \approx 2 \text{ €/train-km}, \ \ \varepsilon \geq 0{,}7 \quad \text{and} \quad \lambda \leq 0{,}3)$$

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[35] As seen in section 1.3.2.3: $\alpha = \dfrac{\lambda}{1+\lambda}$.

CHAPTER 2

POSSIBLE INFLUENCES OF RAILWAY CHARGES ON THE DEVELOPMENT OF HIGH SPEED RAILWAYS IN EUROPE. FORMULATION OF THE PhD THESIS OBJECTIVE

2.1. INTRODUCTION OF THE CHARGE FOR THE USE OF THE INFRASTRUCTURE IN THE EUROPEAN UNION: STATE OF THE ART

Even if Directive 2001/14/EC affirms that “Directive 91/440/EEC (…) and Directive 95/19/EC (…) have not prevented a considerable variation in the structure and level of railway infrastructure charges”, the directive of 2001 does not curtail the Member States liberty of action for setting the charge for the use of the railway infrastructure. As a result of that and considering the fact that each State is responsible for the incorporation of the rules of the Directive in their laws, the transposition to a national level of Directive 2001/14/EC has given rise to very different charging realities in the European Union geographical framework.

The actors responsible for setting the charge for the use of the railway infrastructure in the diferent EU countries are presented next, as well as the cost recovery rates and the pricing principles currently applied in the European railway framework. The process by which costs have been allocated to charges is analysed as well. Finally, the PhD thesis objective is formulated.

2.1.1. Determination of the charge for the use of the infrastructure in the EU

With regard to the determination and application of charges, Directive 2001/14/EC specifies that “Member States shall (...) establish specific charging rules or delegate such powers to the infrastructure manager (... that will determine) the charge for the use of infrastructure” if it is independent of any railway undertaking.

As a result of the implementation of Directive 2001/14/EC, in each EU Member State the responsibility of fixing the charge for the use of infrastructure goes to different organisations. In some cases, charges are set by Government law through a Ministry or a regulatory organisation, while in other countries it is an infrastructure authority or infrastructure companies that set them (see **table 2.1**).

TABLE 2.1 ENTITIES RESPONSIBLE FOR THE CHARGE FOR THE USE OF INFRASTRUCTURE DETERMINATION

Charge determination method	**Country (Entity responsible for the charge determination)**
✓ Without regulation for charge-setting	▪ Ireland
✓ Charges set by law by the Government	▪ Belgium ▪ Czech Republic (Ministry of Finance) ▪ Denmark (National Railway Authority, dependent on the Ministry of Transport and Energy) ▪ Slovak Republic (Ministry of Finance) ▪ Spain (Ministry of Works) ▪ Estonia (Railway Inspectorate) ▪ Finland (Ministry of Transport) ▪ Netherlands (Ministry of Transport, Civil Works and Water Management) ▪ Hungary (VPE, company in charge of the capacity allocation) ▪ Italy (CIPE, Interdepartmental Committee for Economic Programming) ▪ Luxembourg (determined by *Accès Réseau* and approved by the Ministry of Transport) ▪ Norway (Ministry of Transport) ▪ Portugal (Decree-Law 270/2003 of the Ministry of Public Works, Transport and Housing) ▪ United Kingdom (Office of Rail Regulation, ORR) ▪ Sweden (Ministry of Transport and Communications) ▪ Switzerland (FOT, Federal Office of Transport)
✓ Charges set by an infrastructure authority and decided by the Government	▪ Austria (ÖBB Infrastruktur Betrieb AG) ▪ Slovenia (AŽP, railway transport public agency) ▪ France (Proposed by RFF and set in Decrees by the Ministry of Transport) ▪ Greece (set by EDISY and approved by the Ministry of Transport and Communications) ▪ Latvia (LDZ, state-owned railway company) ▪ Lithuania (LG, Lithuanian Railways) ▪ Poland (PLP PKL, according to the rules set by UTK, the Railway Transport Department)
✓ Charges set by (private) infrastructure companies and approved by the corresponding ministry	▪ Germany (DB Netz AG)

In most EU Member States charges for the use of infrastructure are set by a state regulator, i.e. it is the government who sets them.

The characteristics of the pricing systems implemented in the EU by the different entities responsible of the determination of the charge for the use of infrastructure are presented below.

2.1.2. Cost recovery rates

Pricing principles are related to financing, as a result of the fact that infrastructures are considered public goods. The reason why they are considered public goods is that infrastructure maintenance, modernisation and development are part of the global transport politics (Bergougnoux, 2000).

The cost recovery rate concept comes from this interrelation between financing and charging, understood as the total infrastructure manager's cost[36] percentage that is really recovered by access charges. The remaining cost percentage, i.e. the expenses not covered by charging is covered by the State with public subsidies. In other words, to reach a financial stability, infrastructure managers have to set access charges so as to recover an amount equivalent to the difference between total costs and public subsidies of one year.

The level of charges cost recovery, i.e. the upper limit for cost recovery, is a national politics decision, related to the State long-term commitment to the sector (Baritaud et al, 1998; CEMT, 2005b). Therefore, for a given level of costs, the access charge level reflects the amount of State subsidies.

In **figure 2.1** the cost recovery rates of the European rail charges for the year 2004 are presented, published by CEMT (2005b)[37]. Central and Eastern European countries cost recovery rates have been represented in light shading, while the ones for Western European countries have been represented in dark shading.

Figure 2.1 and the shading distinction allows to easily perceive the important differences existing between cost recovery rates in the different European countries, especially between Eastern and Western Europe. Even if some of the differences could be explained by the fact that costs definitions may (and usually do) vary from one infrastructure

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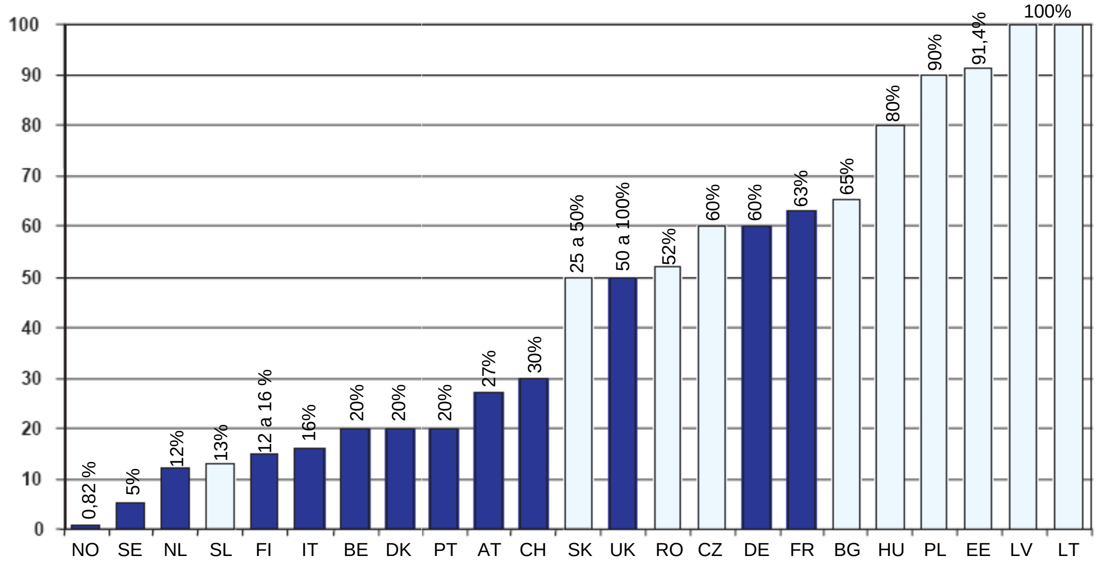
[36] Total costs include (CER, 2005b): maintenance, operation expenses, renewals, interests and depreciation.

[37] The cost recovery rates published by CEMT (2005b) refer to the cost recovery rates of the entire network (and not of a specific section).

manager to another (Calvo, 2007[38]), according to the Economic Commission for Europe (2005) this data shows that infrastructure managers' cost recovery rates are low in rich countries and high in less wealthier countries; i.e. Central and Eastern European governments give only a minimal financial support to infrastructure managers (CE, 2005). The Economic Commission for Europe argues that this can be explained by the fact that rich countries can afford funding their railways, while infrastructure managers in less wealthier countries depend, to a greater extent, on infrastructure charges to cover their own expenses.

FIGURE 2.1 PERCENTAGE OF TOTAL COSTS COVERED BY INFRASTRUCTURE CHARGES IN 2004

Source: Adapted from CEMT (2005b)



- Cost recovery = revenues from charges as a proportion of total expenditure on the network on operations, maintenance, renewals, interest depreciation.
- Light shading indicates Central and Eastern European countries.
- Marginal costs can be expected to lie at roughly 15 to 20% of the cost figures reported.

NO: Norway
SE: Sweden
NL: Netherlands
SL: Slovenia
FI: Finland
IT: Italy
BE: Belgium
DK: Denmark
PT: Portugal
AT: Austria
CH: Switzerland
SK: Slovak Republic
UK: United Kingdom
RO: Romania
CZ: Czech Republic
DE: Germany
FR: France
BG: Bulgaria
HU: Hungary
EE: Estonia
PL: Poland
LV: Latvia
LT: Lithuania

With regard to the first remark (lower cost recovery rates in rich countries), **figure 2.1** shows that most Central and Eastern European (CEE) countries have cost recovery rates above 80% (the Czech Republic, with a 60% cost recovery rate and Slovenia, with a 13%

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[38] In pricing systems based on the marginal cost, differences in the consideration of the different costs could be due to the current little agreement on what cost elements should be considered short-run marginal social cost and how they should be measured (Nash, 2005).

cost recovery rate are the only exceptions). On the contrary, all Western European countries have cost recovery rates below 30%, with the exceptions of the United Kingdom (50%), Germany (60%) and France (63%)[39]. These figures reflect a clear East-West divide between the proportion of infrastructure costs covered by access fees in the CEE countries and the rest of the European Union.

It is of interest to highlight that these cost recovery rates can vary with time. This is because financing is not stable, since it depends on how yearly State budget is structured. **Table 2.2** summarises the evolution of the charges cost recovery rates for different Western European countries in 2001 and 2002. The increase of the cost recovery rate in the Netherlands is due to the obligation coming from DG TREN (General Directorate for Transport of the European Commission), responsible for competition, of changing the nil charging politics to a marginal cost pricing politics. For the rest of the countries, the tendencies are very diverse. This hints at the probability of the existence of very different guidelines for the application of mark ups above marginal costs between European countries.

The pricing systems applied in the different European countries are presented below, with the aim of better understanding the cost recovery rates values presented in this section.

TABLE 2.2 EVOLUTION OF THE CHARGES COST RECOVERY RATES FOR DIFFERENT WESTERN EUROPEAN COUNTRIES

Source: Author's elaboration with data from Profillidis (2001) and CEMT (2005).

Country		Charges cost recovery rate	
		Year 2001	Year 2002
✓	Switzerland	70%	30%
✓	Italy	40%	16%
✓	France	30%	63%
✓	Sweden	5%	5%
✓	Belgium	20%	20%
✓	Netherlands	0% (nil pricing politics)	12%

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[39] According to IRJ (2008), of the first 15 EU members, only France, Germany and the United Kingdom cover currently more than half their infrastructure costs through access charges.

2.1.3. Pricing principles applied

Table 2.3 groups the European countries according to the pricing principle applied in the railway sector (full cost recovery, full cost recovery after State subsidies, marginal cost, and marginal cost with mark ups)[40].

TABLE 2.3 CHARGING PHILOSOPHIES OR PRINCIPLES APPLIED IN DIFFERENT EUROPEAN COUNTRIES
Source: Author's elaboration with data from CEMT (2005) and EC (2007).

FC **(Full cost recovery)**	**FC-** **(Full cost recovery after subsidies)**	**MC** **(Marginal cost)**	**MC+** **(Marginal cost with mark ups)**
✓ Slovenia	✓ Germany	✓ Greece	✓ Austria
✓ Hungary	✓ Belgium	✓ Netherlands	✓ Bulgaria
✓ Latvia	✓ Estonia	✓ Portugal	✓ Denmark
✓ Poland	✓ Italy[1]		✓ Spain
✓ Romania			✓ Finland
			✓ France
			✓ United Kingdom
			✓ Czech Republic
			✓ Sweden
			✓ Switzerland

Remarks:
[1] Only traffic management
- Data not available for Lithuania, Luxembourg and the Slovak Republic.
- Passenger trains are not charged in Norway.

The information presented in **table 2.3** allows identifying the following tendencies:

- *Full cost recovery* practice (FC) is only applied in CEE countries, specifically in Slovenia, Hungary, Poland, Latvia and Romania.

- *Full cost recovery after subsidies* (FC-) is mainly used in Western Europe: three Western European countries have adopted this charging principle, namely Italy, Belgium and Germany, the railway networks of which have high speed lines in

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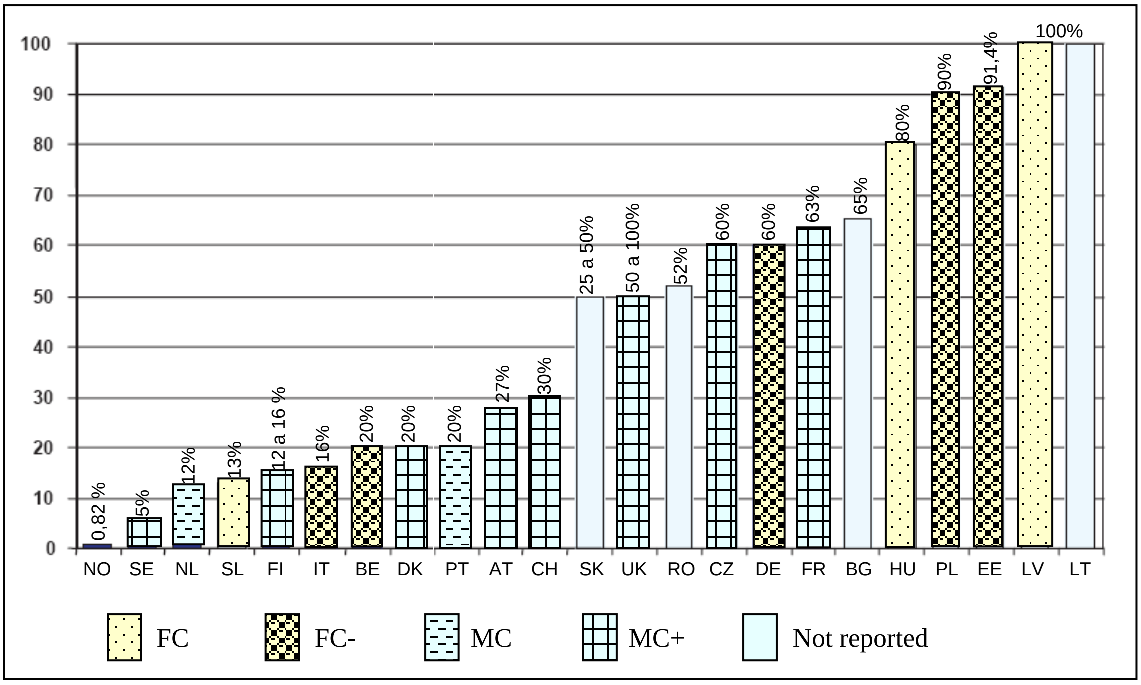
[40] Even if the pricing principles presented in **table 2.3** are representative of each country, in some particular links pricing principles can differ from the representative one.

operation. In Central and Eastern Europe, only Estonia charges according to this pricing philosophy.

- *Marginal cost charging* (MC) is exclusively applied in Western Europe although it is not widespread there.

- *Marginal cost with mark ups* (MC+) is the most widespread charging principle in Europe, being the main pricing philosophy in Western European networks. France, Spain, the United Kingdom, Denmark and Sweden, all with high speed lines in operation, apply it. However, in Central and European networks only one IM has adopted this charging principle.

FIGURE 2.2 PERCENTAGE OF TOTAL COSTS COVERED BY INFRASTRUCTURE CHARGES IN 2004, DISTINGUISHING BY PRICING PRINCIPLE
Source: Author's elaboration with data from CEMT (2005) and CEMT (2005b)



These tendencies show that Eastern countries tend to apply a full cost recovery principle, while Western countries favour systems based on marginal costs (with or without mark ups), along the lines of the proposal found in Directive 2001/14/EC. As expected by the intrinsic definition of full cost recovery, the application of a full cost recovery pricing is strongly linked with high cost recovery rates (see **figure 2.2**). However, it is important to highlight that there are great differences in the cost recovery rates between countries with a “marginal costs with mark ups” pricing. Specifically, cost recovery rates range from 5% in Sweden to 63% in France, according to CEMT (2005) data. This shows the great flexibility of this pricing philosophy, which allows recovering an important part of the costs (in some cases, its value approaches the percentage of costs covered by full cost recovery after subsidies pricing systems).

TABLE 2.4 PRICING STRUCTURES APPLIED BY THE RAIL INFRASTRUCTURE PRICING PRINCIPLES IN THE EU
Source: Author’s elaboration with data from CEMT (2005).

Linear tariff		Two-part tariff
✓ Germany	✓ Netherlands	✓ France
✓ Austria	✓ Latvia	✓ Hungary
✓ Belgium	✓ Poland	✓ Italy
✓ Denmark	✓ Portugal	✓ Lithuania
✓ Slovak Republic	✓ Czech Republic	✓ United Kingdom
✓ Slovenia	✓ Sweden	✓ Spain
✓ Estonia	✓ Switzerland	
✓ Finland		

Remarks:
- Data not available for Greece and Luxembourg.
- Passenger trains are not charged in Norway.

With regard to the pricing structures implemented in the EU countries, most European countries have implemented linear tariffs (see **table 2.4**). However, countries with high speed lines in operation where pricing systems are based on marginal costs have a two-part tariff structure[41].

2.1.4. Cost allocation in the charges for the use of infrastructure

The recovery of costs derived from the use of railway infrastructure is characterised by the variables defined in each country for allocating costs and calculating the charge for the use of infrastructure.

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[41] As presented in section 4.2.4, although Italy affirms to apply a full cost after subsidies pricing principle, it would seem that the charges calculation is based on marginal costs. Sweden and Denmark, where high speed lines are big civil works (bridges and tunnels), do not have a two-part tariff structure.

In **table 2.5** the cost categories supposedly covered by the infrastructure charges implemented in different European countries are presented[42]. Amongst them we find investment expenses, and financial, maintenance, renewal, traffic management, accident, air pollution, noise and congestion/scarcity costs.

Charges for the use of infrastructure cover, in some cases, part of the new high speed lines, upgraded lines and big civil works (such as bridges of great magnitude[43]) investment costs. Nowadays, among countries with high speed lines, France, Spain, Germany and Denmark (the latter with high speed lines that run along two big bridges, the Great Belt –Storebælt– and the Öresund) cover part of the investment costs of their high performance lines. The European countries that do not partially or fully cover the high performance infrastructure investment costs (either because they do not have such infrastructure or because they have decided not to cover part of the expenses by means of infrastructure charges) present lower cost recovery rates than those of the countries that do cover them (cost recovery rates lower than 20% for Western European countries and lower than 80% for CEE countries). Therefore the consideration of investment costs by pricing systems plays an important role in the cost recovery rate.

With regard to the recovery of maintenance costs, all countries cover wholly or partially this cost category by means of infrastructure charges, except for the Italian pricing system. In the other countries with high speed lines in operation, maintenance costs are either totally covered by pricing systems (for instance, in Germany and the United Kingdom) or partially covered (Denmark, France and Sweden). In Spain it is not clear whether maintenance costs are wholly or only partially recovered.

Although the maintenance cost category is the most widespread in the European railway pricing systems (together with the traffic management cost category) this is not the case of renewal costs, even if they are also linked to track wear and tear. Amongst the countries that do recover al least part of maintenance costs by means of infrastructure charges, those applying a first best pricing (the Netherlands and Portugal) do not cover renewals costs.

With regard to the costs linked to traffic management, all pricing systems except for the Finish one seem to cover them.

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[42] Belgium and the rest of EU-25 countries with railways not included in **table 2.5** have not been analysed due to lack of data. Norway has not been included in the table because the Norwegian pricing system does not include charges for passenger services.

[43] Conventional railway lines investment costs are considered sunk costs (i.e. costs that were incurred in the past and that cannot be recovered).

TABLE 2.5 COSTS COVERED BY RAIL INFRASTRUCTURE CHARGES IN EUROPE

Source: Sánchez-Borràs from ECMT (2005) and other sources

		AT	CZ	**DK**	EE	FI	**FR**	**DE**	HU	**IT**	LV	NL	PL	PT	SL	**ES**	SE	CH	**UK**
🟧	YES				X														
	Y/N	X		X			X	X			X		X			X			
	NO		X			X			X	X		X		X	X		X		
🟧	YES				X								X						
	Y/N								X							X			
	NO														X				
🟨	YES	X			X			X			X		X						X
	Y/N		X	X		X	X					X		X	X	X	X		
	NO									X									
🟨	YES				X				X		X								X
	Y/N	X				X	X	X					X		X				
	NO		X							X		X		X			X		
🟨	YES				X			X			X		X						X
	Y/N		X	X			X			X		X		X	X	X	X		
	NO					X													
⬜	YES																		
	Y/N					X					X		X						
	NO		X		X		X	X	X			X		X	X	X			X
⬜	YES																		
	Y/N					X					X		X						
	NO				X		X	X	X			X		X	X	X			X
⬜	YES																		
	Y/N					X		X			X		X						
	NO		X		X		X		X			X		X	X	X			X
⬜	YES		X				X							X					
	Y/N					X					X		X						
	NO				X				X							X			

Remarks:
- In bold, countries with new high speed lines in operation
- YES: Cost covered by rail infrastructure charges
- Y/N: Cost partly covered by rail infrastructure charges
- NO: Cost not covered by rail infrastructure charges
- Blank: no information available
- Type of cost:

🟧	Investment expenditures	⬜	Accident costs
🟧	Finance costs (loan costs)	⬜	Air pollution costs
🟨	Maintenance	⬜	Noise costs
🟨	Renewal	⬜	Scarcity/congestion costs
🟨	Traffic management		

- Data for Spain has been obtained from the legal documents defining the infrastructure charging system. Since it is not clear whether the costs indicated are wholly or only partially covered by infrastructure charges, they have all been classified as being partially covered.
- In Denmark, charges cover the short-run marginal cost (SRMC) and part of investment expenditures. In order to elaborate this table, SRMC has been interpreted as Denmark recovering part of traffic management costs and part of maintenance costs.

Finally, **table 2.5** shows that the recovery of external costs by infrastructure charges is not a common practice amongst the European pricing systems, as seen in section 1.4.2.2. Only Finland, Latvia and Poland seem to consider those costs. On the other hand, congestion and scarcity costs seem to be internalised by means of infrastructure charges in France, Portugal and the Czech Republic, while Germany partially internalises noise costs with its infrastructure charges.

Even if the cost categories supposedly covered by pricing systems are the ones presented in the preceding paragraphs, cost categories are generally regrouped when calculating charges, according to the following cost categories (CEMT, 2005):

- Train planning and operations
- Electricity
- Congestion and scarcity
- Maintenance and renewals
- External costs
- Mark ups[44] and other services

The existing link between cost categories covered by pricing systems and cost categories used to calculate infrastructure charges in Europe have been summarised in **table 2.6**.

The analysis of the network statements valid in 2006 in the European railway networks show cost categories other than the ones presented up to this point, which correspond to those used when determining the amount of charges to be paid for the use of the railway infrastructure. The differences between the cost categories covered by pricing systems in Europe and the ones actually used to charge the use of railway infrastructure reflect, to some extent, the difficulties for quantifying the costs derived from the use of the infrastructure and allocating them to the runs that take place in the network.

The categories detected in the network statements, even if they are in some way linked to the cost categories used for the calculation of charges, show some differences with regard to the latter, as **table 2.6** shows. Specifically, when calculating charges the cost categories “train planning and operations” and “maintenance and renewals” are included within the category “trains movement” in most cases. The Spanish case is an example at hand: in Spain the running charge (or the charge for trains’ movement) covers, according to the Ministerial Order of 2005 where the amount of railway charges is defined (MFOM, 2005), the variable maintenance, operation and management costs. On the other hand, the cost categories “Access charge” and “Capacity reservation” detected in the network statement,

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[44] By “mark ups” it is meant “mark ups above marginal cost”.

could be included in the category “Mark ups and other services”, as will be justified in the following paragraphs.

In this sense, it is of special interest to analyse the evolution undergone in the amount of the charges attributed to, on the one hand, the cost category “trains movement” (where theoretically short-run marginal costs should be included) and, on the other hand, the cost category “capacity reservation”, in countries with high speed lines in operation. This analysis unveils the possible cost categories to which mark ups above marginal cost have been allocated.

TABLE 2.6 COST CATEGORIES OF THE PRICING STRUCTURES IMPLEMENTED IN EUROPE

Source: Author’s elaboration with data from CEMT (2005) and the network statements valid in 2006 in the European countries with pricing systems.

Cost categories covered by the European pricing systems **(according to CEMT, 2005)**	**Cost categories generally used for the calculation of charges in the EU** **(according to CEMT, 2005)**	**Cost categories detected in the pricing systems currently used in the EU in 2006** **(based on the network statements)**
✓ Traffic management	✓ Train planning and operations	✓ Trains movement
✓ Maintenance costs ✓ Renewal costs	✓ Maintenance and renewals	✓ Maintenance
	✓ Electricity	✓ Energy/electricity
✓ Accident costs ✓ Air pollution costs ✓ Noise costs	✓ External costs	✓ Security
✓ Congestion/scarcity costs	✓ Congestion and scarcity	✓ Congestion
✓ Investment expenditures ✓ Financing costs	✓ Mark ups and other services	✓ Access ✓ Capacity reservation ✓ Information

Remarks:

- The cost category “Capacity reservation” has been considered to be included within the calculation category “Mark ups and other services” rather than within the one corresponding to “Congestion and scarcity”.

FIGURE 2.3 EVOLUTION OF THE CHARGES IN THE FRENCH RAILWAY NETWORK FROM 1997 TO 2004
Source: Adapted from Richard et al. (2005)

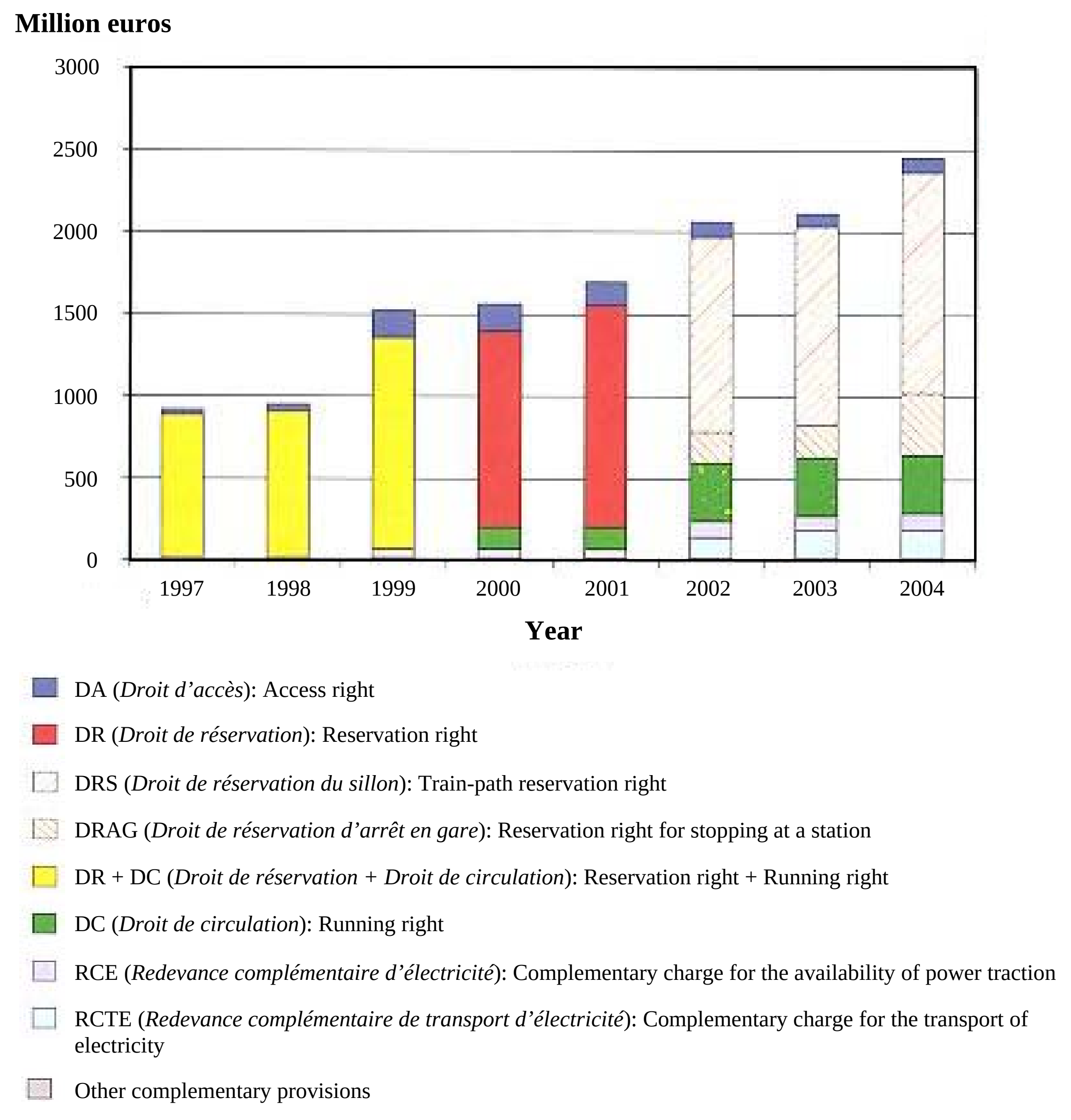

Figure 2.3 presents the evolution of charges in the French railway network from 1997 to 2004. This figure not only shows the considerable increase experienced by charges in the 1997-2004 period (the money levied from charges more than doubled in the 1997-2004[45] period) but also gives information on the cost category/ies to which those increases have

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[45] This increase can be explained by the French railway infrastructure manager's (RFF, Réseau Ferré de France) objective, which was to reach the "small equilibrium", that is, to bring global charges (excluding the complementary charge for the transport of electricity) and main operation expenses (the remuneration of the French national railway operator, SNCF, for the network management that carries out on behalf of RFF) to the same level from the year 2008 (Richard et al, 2005).

been allocated. Specifically, it can be seen that in 2004 the amount of the cost categories "access" and "capacity reservation" was strongly risen compared to the preceding years (2000 to 2003, in which the capacity reservation cost category was already treated as a separate cost category). This fact seems to show that it is in these cost categories where mark ups are allocated.

On the other hand, the cost category "trains' movement" (running right) was almost trebled in the pricing system introduced in 2002 compared to the one in force in the two preceding years. This could indicate an increase of the running charge derived from an increase in the number of runs, and/or from a deeper knowledge of marginal costs that could have been shown to be higher than the amount previously charged, and/or from the introduction of mark ups based on wear and tear and, consequently, attributed to this cost category. Therefore, it would seem that this cost category is not exempt from mark ups (nor perhaps the other cost categories).

Once the cost categories covered and used by pricing systems in force in the European railway sector are known, it is interesting to shed light on the cost allocation process to charges, i.e. which variables the different pricing systems have defined to allocate costs to charges for the use of infrastructure.

As for the link between charges and the costs attributable to infrastructure services, as well as with regard to the variables to be used for calculating the charge, section 1.4.1 showed that the European legislative framework in force stipulates that "the relative magnitudes of the infrastructure charges shall be related to the costs attributable to the services" (Article 7 of Directive 2001/14/EC) and that "the user fee (…) may in particular take into account the mileage, the composition of the train and any specific requirements in terms of such factors as speed, axle load and the degree or period of utilisation of the infrastructure" (Article 8 of Directive 91/440/EEC).

In practice, the determination of the variables for charging the different costs to infrastructure users is determined by the nature of the cost categories presented in the preceding section. In spite of that, the existence of divergences with regard to the consideration of a cost as fixed or variable and the difficulty, in some cases, of having access to enough data for determining the costs explains that different variables can be used for charging a same cost element in different administrations.

For instance, according to CEMT (2005), the (marginal) cost element derived from train planning and operations is usually charged by planned train-path or by train-km, or even by the number of saturated nodes that have to be crossed. On the other hand, electricity, a typical cost element in electric power trains, can be calculated with variables that distinguish between electric power and diesel trains, or variables that allow estimating the catenary wear and tear. With regard to the congestion and scarcity cost category, charges can vary with time and place according to the capacity usage intensity and the capacity needed for the train, which depends on the relationship between its speed and that of the other trains. The cost element maintenance and renewals, which depends on the characteristics of the rolling stock (axle load, non-suspended weight, etc.), the train maximal speed and the track, can be charged with gross tonnes-km or with vehicle or train-km. Finally, with regard to the external cost elements, they can be charged, amongst other variables, according to gross tonnes-km, vehicle-km or train-km, depending on the rolling stock environmental performances and, in some cases, on the place and time as well.

TABLE 2.7 MAIN VARIABLES OF THE CHARGES FOR THE USE OF RAIL INFRASTRUCTURE
Source: Adapted from CEMT (2005).

Country	Charges per:				Other
	Gross t-km	Train-km	Path-km	Km of the train-path	
Germany		✓			
Austria	✓	✓			
Belgium		✓			
Bulgaria	✓	✓			Charges per train-path
Denmark		✓			Charges per train for bottlenecks and bridges
Estonia	✓	✓			
Finland	✓				
France		✓		✓	
Hungary		✓	✓		
Italy			✓		Also charge per node
Latvia		✓			
Netherlands		✓			
Poland		✓	✓		
Portugal		✓			
Czech Rep.	✓	✓			
Romania	✓				
U. Kingdom		✓			Per vehicle km by type of vehicle
Slovenia		✓			
Sweden	✓				Öresund bridge surcharge
Switzerland	✓	✓			Also charge per node

As a summary of the preceding considerations, in its publication "Railway reform and charges for the use of infrastructure" (CEMT, 2005)[46], CEMT presents the most common variables in the charges for the use of rail infrastructures, as presented in **table 2.7**.

The author of this PhD thesis has carried out a more in-depth analysis on the variables used by the different infrastructure managers in Europe (Teixeira, Sánchez Borràs et al, 2007; Sánchez Borràs et al, 2007), on the basis of the network statements valid in 2006 in the countries within the EU-25 geographical framework, except for Cyprus and Malta (which currently have no railways), plus Switzerland and Norway. The analysis presented in the following paragraphs, not only brings to light all the variables used by European rail pricing systems, but also allows shedding light to the variables used by the different pricing systems to determine the amount allocated to each cost category, included the one for mark ups.

Although the liberty enjoyed by the different countries when choosing the parameters used already pointed to the existence of a wide range of possible variables used, the results found show a striking heterogeneity. **Table 2.8** contains the variables used by the infrastructure managers of the European geographical framework when charging the cost categories previously presented. In total 46 different variables have been identified (see the third column of said table), which can be grouped into 6 typologies of variables:

- The *type of infrastructure used* (constituted by 7 variables): This first category groups the charging variables that allow defining and characterising the network, the track or the stations, as well as those that refer to the network specificities, such as the existence of railway bridges.

- The *type of allocation requested* (it groups 12 variables): This second category contains those charging variables related to train-paths, traffic expected, time period, length of the reservation and transport characteristics.

- The *type of service* (constituted by 4 variables): The category related to the type of service includes variables that refer to the involved stakeholders or to the type of service itself, both considering geography (international traffic, national traffic, etc.) and the characteristics of the service (passengers or freight).

- The *type of rolling stock used* (it groups 7 variables): This category groups the variables that allow characterising the trains and the wear and tear caused by them.

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[46] Also published in French under the title: "Réforme ferroviaire & tarification de l'usage des infrastructures".

- The *service offered* (constituted by 11 variables): The category linked with the service offered groups variables related to the runs, that is, the route, the stops at stations, etc.

- The *type of traction* (it groups 5 variables): Finally, the type of traction category groups the variables that refer to the type of traction and energy consumption.

TABLE 2.8 VARIABLES USED BY THE EUROPEAN RAIL PRICING SYSTEMS
Source: Sánchez Borràs (2007b).

Categories of variables considered		Variables considered
1. Type of infrastructure used	✓ Network	▪ Category/type of line/network ▪ Admissible load on rail ▪ Speed of the section
	✓ Specificities	▪ Specific links ▪ Special infrastructure (bridges, tunnels…)
	✓ Stations	▪ Station category ▪ Distinction departing trains, arrival, …
2. Type of allocation requested	✓ Train-path	▪ Type of train-path requested ▪ Train-path ▪ Train-path / km
	✓ Traffic	▪ Transport contract (number of trips requested) ▪ Level of traffic (number of train-km/year)
	✓ Time period	▪ Annual period ▪ Time period ▪ Nocturnal period
	✓ Length of the reservation	▪ Year
	✓ Transport	▪ Special transport conditions ▪ Level of running priority ▪ According to the number of people and per trip
3. Type of service	✓ Stakeholders	▪ Railway undertaking (RU) / Type of RU
	✓ Field of service	▪ Geographical zone/charging zone ▪ Type of traffic (Distinction passengers/freight) ▪ Domestic/international/regional/high speed…

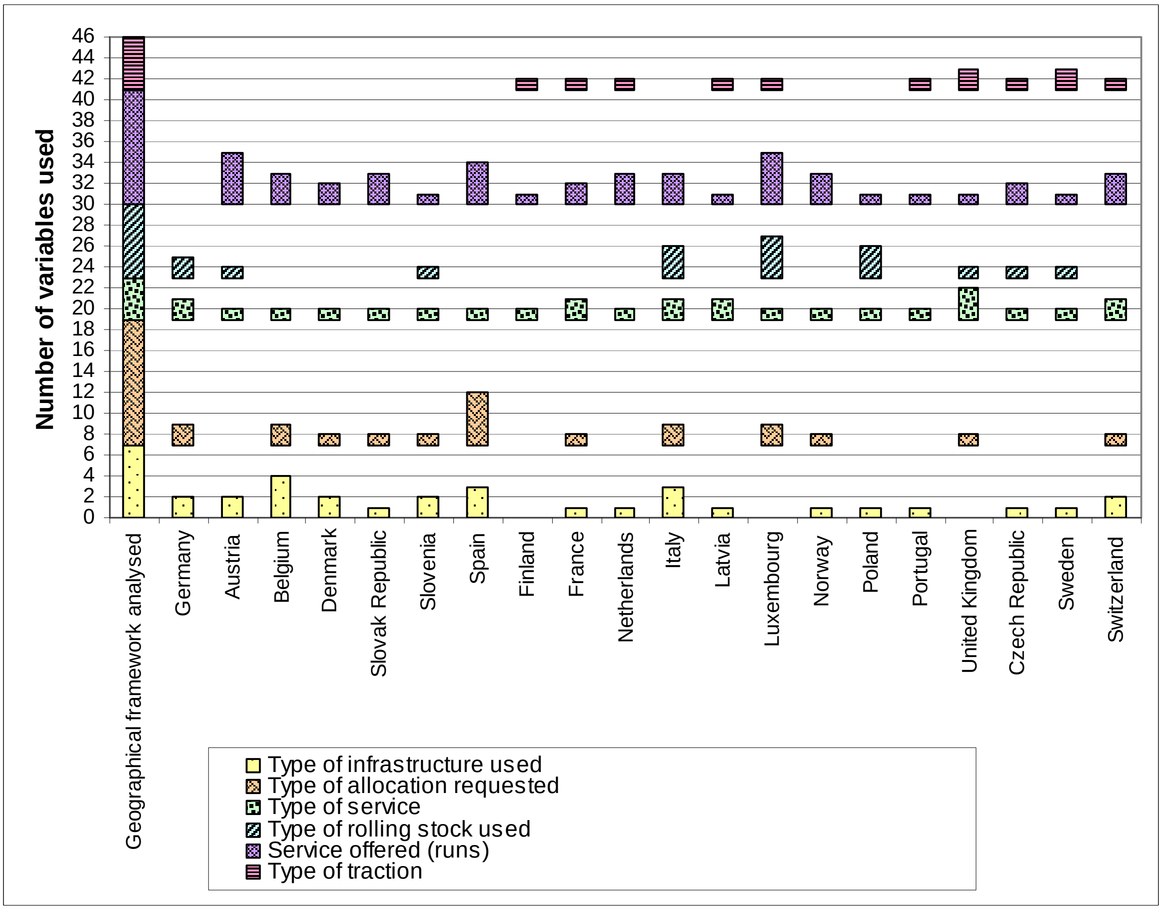
Categories of variables considered		Variables considered
4. Type of rolling stock used	✓ Train characteristics/ wear and tear produced	▪ Type of train ▪ Type of traction unit ▪ Train speed ▪ Use of titling technology ▪ Train's weight ▪ Number of pantographs of the train ▪ Number of bodies/boxes of the train
5. Service offered (runs)	✓ Route	▪ Kilometres covered (total length) ▪ Trains-km ▪ Seats-km ▪ Tonne-km or Gross tonne-km ▪ Number of trains/movement of trains
	✓ Stops at stations	▪ Stop/Station/Arrival or departure at a station ▪ Minutes (at a station/node) ▪ Number of passengers
	✓ Performance indicator	▪ Performance regime/delay/minutes ▪ Saturation, temporary and local bottlenecks ▪ Traffic density
6. Type of traction	✓ Type of traction	▪ Electric/diesel traction
	✓ Consumption (measuring units used)	▪ KWh consumed ▪ Electric train-km ▪ Diesel litres consumed ▪ Day/night

Remarks: Data obtained from the network statements (valid for the year 2006) of the infrastructure managers with railway networks within the geographical framework defined by EU-25 countries, with the exception of Cyprus and Malta, plus Switzerland and Norway.

It is to be noted that the variables used in the pricing systems are of diverse natures. Some reflect quantitative aspects (variables corresponding to measure units), while other reflect aspects with a rather qualitative character. In the latter case, we find variables such as the type of traffic (distinction between passengers and freight traffic), the time period and the train type, amongst others.

Figures 2.4 and **2.5** reflect which and how many of these six categories of variables out of the 46 variables identified at the European level are applied in each country. A low number of variables is used in each country compared to the total 46 defined at the European level: indeed, out of the 46 variables identified in the railway pricing framework, most countries only use between 6 and 13 variables that can be grouped into 4-5 categories out of the total 6 defined.

FIGURE 2.4 NUMBER OF VARIABLES USED BY THE DIFFERENT EUROPEAN PRICING SYSTEMS ACCORDING TO THE TYPES OF VARIABLES DEFINED
Source: Sánchez Borràs et al (2007b)



Even if the number of variables used in each country compared to the ones defined at the European level is low, all six categories of variables defined have a considerable weight, since:

- All countries have variables within the category relative to the type of service.
- 95% of the countries use variables that belong to the category relative to the service offered (runs) in order to determine the amount of charge to be paid.
- 85% of the countries charge different amounts according to the type of infrastructure used.
- 60% of the countries have variables to characterise the type of allocation requested.
- 50% of the countries use variables to define the type of traction.

FIGURE 2.5 VARIABLES USED BY EUROPEAN RAIL INFRASTRUCTURE MANAGERS
Source: Sánchez-Borràs for CENIT (2007)

Categories of variables		Variables	Germany	Austria	Belgium	Denmark	Spain	Slovak Republic	Slovenia	Estonia	Finland	France	Greece	Netherlands	Hungary	Ireland	Italy	Latvia	Lithuania	Luxembourg	Norway	Poland	Portugal	United Kingdom	Czech Republic	Sweden	Switzerland
Type of traction	Consumption (measuring units used)	Day/night																									✓
		Diesel litres consumed																								✓	
		Electric train-km										✓								✓							
		KWh consumed												✓										✓			
	Type of traction	Electric/diesel traction									✓							✓					✓	✓	✓	✓	
Service offered (runs)	Performance indicator	Traffic density															✓										
		Saturation, temporary and local bottlenecks		✓																✓							
		Performance regime/delay/minutes		✓	✓															✓							
	Stops at stations	Number of passengers					✓																				
		Minutes (at a station/node)															✓										
		Stop/Station/Arrival or departure at a station		✓	✓							✓		✓						✓							✓
	Route	Number of trains/movement of trains				✓		✓													✓						
		Tonne-km or Gross tonne -km		✓				✓			✓			✓							✓				✓	✓	✓
		Seats-km					✓																				
		Trains-km		✓		✓	✓	✓	✓					✓				✓		✓	✓	✓	✓	✓	✓		✓
		Kilometres covered (total length)			✓		✓					✓					✓			✓							
Type of rolling stock used	Train characteristics/Wear and tear produced	Number of bodies/boxes of the train																		✓							
		Number of pantographs of the train															✓										
		Train's weight	✓														✓			✓		✓					
		Use of titling technology	✓																						✓		
		Train speed															✓			✓		✓					
		According to mobility/type of traction unit		✓																✓							
		Type of train							✓													✓		✓		✓	
Type of service	Field of service	Domestic/international/regional/high-speed...										✓					✓	✓									✓
		Type of traffic (distinction passengers/freight)	✓	✓	✓	✓	✓	✓	✓		✓	✓					✓	✓		✓	✓	✓	✓	✓	✓	✓	✓
		Geographical zone/charging zone	✓																					✓			
	Stake-holders	Railway undertaking (RU)/Type of RU												✓										✓			
Type of allocation requested	Transport	According to the number of people and per trip					✓																				
		Level of running priority			✓																✓						
		Special transport conditions						✓																			
	Length of reservat.	Year					✓																				
	Time period	Noctural period																									✓
		Time period			✓	✓	✓					✓					✓			✓							
		Annual period																						✓			
	Traffic	Level of traffic (number of train-km/year)					✓																				
		Transport contract (number of trips requested)					✓																				
	Train-path	Train-path/km	✓																								
		Train-path																		✓							
		Type of train-path requested	✓						✓								✓										
Type of infrastructure used	Stations	Distinction departing trains, arrival, ...			✓																						
		Station category	✓	✓	✓		✓		✓					✓			✓										✓
	Specifici-ties	Special infrastructure (bridges,tunnels, ...)				✓																					
		Specific links				✓															✓						
	Network	Speed of the section					✓										✓					✓					
		Admissible load on rail			✓																						
		Category/type of line/network	✓	✓	✓		✓	✓	✓			✓					✓	✓					✓		✓	✓	✓

Remarks:

- Greek, Irish and Lithuanian rail charging systems not available in 2006
- Estonian and Hungarian charging systems could not be interpreted since they were only published in the official language of the respective country

- 45% of the countries consider the type of rolling stock for charging purposes.

But rather than the difference between the number of variables used or the weight of each category of variable, the most important aspect of the analysis lies in the study of the variables used for quantifying each of the cost categories defined by the pricing systems implemented in Europe. **Figure 2.6**[47] shows this information. It allows the following statements with regard to the two cost categories detected in the pricing structures implemented in Europe that would be included in the cost category "mark ups and other services":

- *The cost category "capacity reservation" is only defined in the charging systems of those countries with high speed lines in operation* plus Luxembourg (see **figure 2.7**): For its quantification, the different countries use four typologies of variables: type of infrastructure used, type of allocation requested, type of service and service offered (runs). The variables included within these typologies allow differentiating the time period, type of train, performances and type of category. This allows affirming that a Ramsey pricing may be applied when determining the mark ups for high speed lines.

- *The cost category "access" is only defined in the charging systems of those countries with high speed lines in operation* plus the Netherlands and the Slovak Republic (see **figure 2.7**): The variables used in the countries with high speed lines in operation are comprised within the same typologies as those detected for the cost category "capacity reservation". Nevertheless, the variables included in these typologies do not only allow implementing mark ups according to demand elasticity (variable mark ups), but also introducing fixed mark ups.

These statements do not imply that mark ups are only applied in countries with high speed lines in operation: as it has been previously pointed out, all cost categories can be subject to mark ups above marginal costs. However, they show that it is very likely that high performance lines (or runs) are charged higher mark ups than the rest of lines, since networks with high speed lines in operation are subject to an additional cost category to which mark ups aimed at increasing the cost recovery by infrastructure charges are mainly and uniquely allocated.

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[47] In some countries, such as for instance Germany, the structure of the pricing system implemented does not allow distinguishing between cost categories, probably as a result of the pricing principle implemented (full cost recovery after State subsidies). In these cases, all variables have been allocated to the "trains movement" cost category.

FIGURE 2.6 VARIABLES USED FOR DEFINING THE CHARGE TO BE ASSIGNED TO EACH COST CATEGORY DEFINED IN THE EUROPEAN IM'S NETWORK STATEMENTS

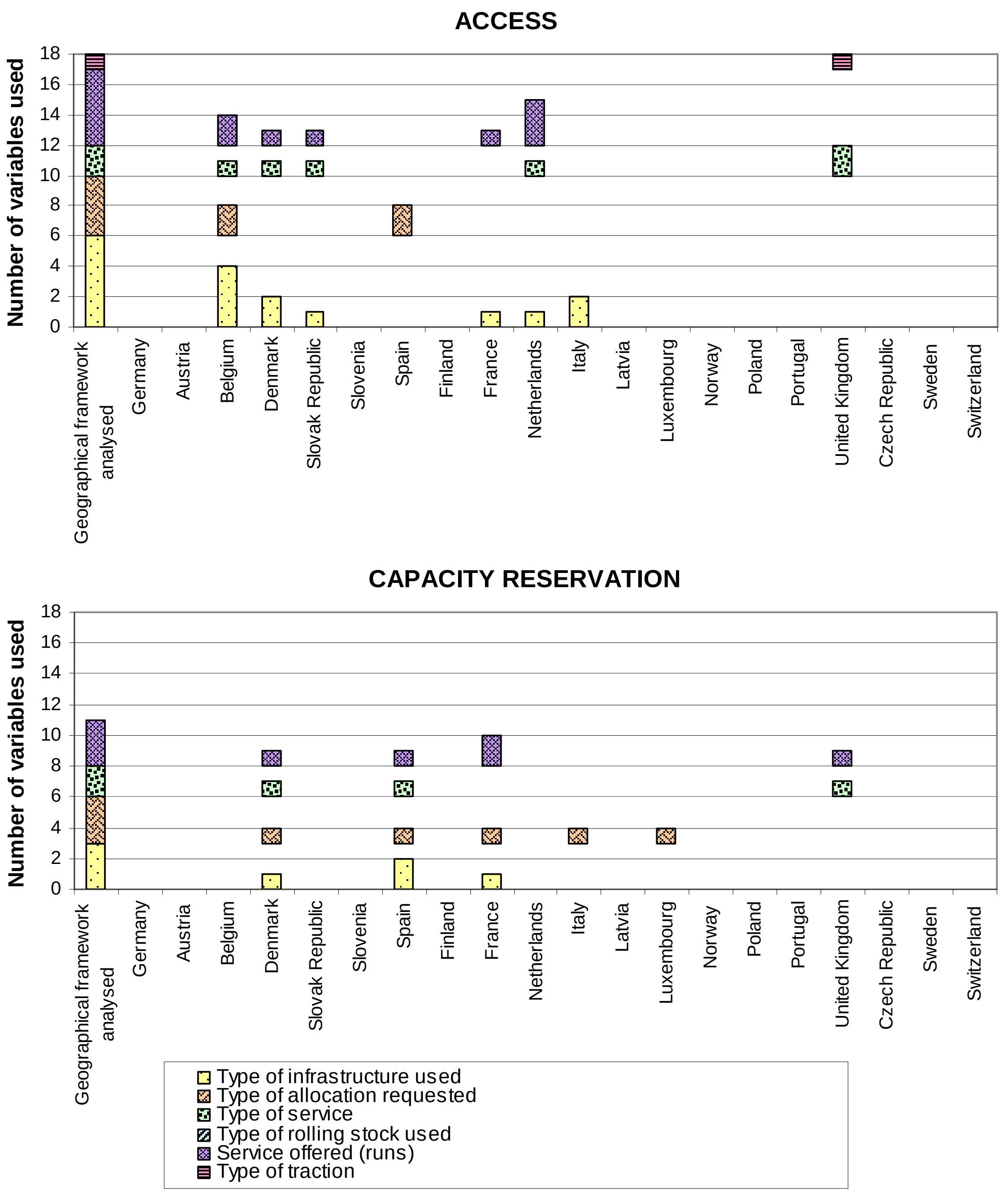
Source: Sánchez-Borràs for CENIT (2007)

Cost category	Categories of variables for allocating the cost to the infrastructure charge		Variables for allocating the cost to the infrastructure charge	DE	AT	BE	DK	ES	EE	FI	FR	GR	HU	IE	IT	LV	LT	LU	NO	NL	PL	PT	UK	SK	SI	SE	CH	CZ
ACCESS	Type of infrastructure used	Network	Category/type of line/network			✓					✓				✓									✓				
			Admissible load on rail			✓																						
		Specificities	Specific links				✓																					
			Special infrastructure (bridges, tunnels…)				✓																					
		Stations	Station category			✓									✓					✓								
			Distinction departing trains, arrival, …			✓																						
	Type of allocation requested	Traffic	Level of traffic (number of train-km/year)					✓																				
		Time period	Time period			✓																						
		Length of the reservation	Year					✓																				
		Transport	Level of running priority			✓																						
	Type of service	Stakeholders	Railway undertaking (RU)/Type of RU																	✓			✓					
		Field of service	Type of traffic (Distinction passengers/freight)			✓	✓																✓	✓				
	Service offered (runs)	Route	Km covered (Total length)			✓					✓																	
			Trains-km																	✓								
			Tonne-km or Gross tonne-km																	✓								
			Number of trains/movement of trains				✓																	✓				
		Stops at stations	Stop/Station/Arrival or departure at a station			✓														✓								
	Type of traction	Type of traction	Electric/diesel traction																				✓					
CAPACITY RESERVATION	Type of infrastructure used	Network	Category/type of line/network					✓			✓																	
			Speed of the section					✓																				
		Specificities	Specific links				✓																					
	Type of allocation requested	Train-path	Type of train-path requested												✓													
			Train-path															✓										
		Time period	Time period				✓	✓			✓																	
	Type of service	Stakeholders	Railway undertaking (RU)/Type of RU																				✓					
		Field of service	Type of traffic (Distinction passengers/freight)				✓	✓																				
	Service offered (runs)	Route	Km covered (Total length)								✓																	
			Trains-km					✓															✓					
			Number of trains/movement of trains				✓																					
		Stops at stations	Stop/Station/Arrival or departure at a station								✓																	
TRAINS MOVEMENT	Type of infrastructure used	Network	Category/type of line/network	✓	✓	✓		✓			✓				✓	✓						✓		✓	✓	✓	✓	✓
			Admissible load on rail			✓																						
			Speed of the section					✓							✓						✓							
		Specificities	Specific links				✓												✓									
			Special infrastructure (bridges, tunnels…)				✓																					
		Stations	Station category	✓	✓	✓		✓							✓										✓		✓	
			Distinction departing trains, arrival, …			✓																						
	Type of allocation requested	Train-path	Type of train-path requested	✓																					✓			
			Train-path/km	✓																								
		Time period	Time period			✓		✓							✓													
		Transport	Special transport conditions																					✓				
			Level of running priority			✓													✓									
	Type of service	Field of service	Geographical zone/charging zone	✓																								
			Type of traffic (Distinction passengers/freight)	✓	✓	✓	✓	✓		✓	✓				✓	✓		✓	✓		✓	✓		✓	✓	✓	✓	✓
			Domestic/ international/ regional/high-speed…								✓				✓	✓											✓	
	Type of rolling stock used	Train characteristics / wear and tear produced	Type of train																		✓		✓		✓	✓		
			According to mobility/type of traction unit		✓													✓										
			Train speed												✓						✓							
			Use of titling technology	✓																								✓
			Train's weight	✓											✓			✓			✓							
			Number of pantographs of the train												✓													
			Number of bodies/boxes of the train															✓										
	Service offered (runs)	Route	Km covered (Total length)			✓		✓			✓				✓													
			Trains-km		✓		✓	✓								✓		✓	✓		✓	✓		✓	✓		✓	✓
			Seats-km					✓																				
			Tonne-km or Gross tonne-km		✓					✓									✓					✓		✓		✓
			Number of trains/movement of trains				✓												✓									
		Stops at stations	Stop/Station/Arrival or departure at a station		✓	✓																					✓	
			Minutes (at a station/node)												✓													
			Number of passengers					✓																				
		Performance indicator	Performance regime/delay/ minutes		✓	✓																						
			Traffic density												✓													
	Type of traction	Type of traction	Electric/diesel traction							✓						✓						✓						✓
		Consumption	KWh consumed																	✓								
ENERGY / ELECTRICITY	Type of infrastructure used	Network	Category/Type of line/network												✓												✓	
		Stations	Station category												✓													
	Type of allocation requested	Time period	Annual period																				✓					
			Time period															✓										
			Nocturnal period																								✓	
	Type of service	Field of service	Geographical zone/charging zone																				✓					
			Type of traffic (Distinction passengers/freight)								✓							✓								✓	✓	
			Domestic/ international/ regional/high-speed…								✓																✓	
	Type of rolling stock used	Train characteristics / wear and tear produced	Train speed															✓										
			Train's weight															✓										
			Number of bodies/boxes of the train															✓										
	Service offered (runs)	Route	Km covered (Total length)												✓													
		Stops at stations	Stop/Station/Arrival or departure at a station															✓										
	Type of traction	Type of traction	Electric/diesel traction																							✓		
		Consumption (measuring units used)	KWh consumed																				✓					
			Electric Train-km								✓							✓										
			Diesel litres consumed																							✓		
			Day/Night																								✓	
INFORMATION	Type of infr. used	Network	Category/Type of line/network																							✓		
	Service offered (runs)	Route	Tonne-km or Gross tonne-km																							✓		
MAINTENANCE	Type of service	Field of service	Type of traffic (Distinction passengers/freight)																								✓	
	Service offered (runs)	Route	Tonne-km or Gross tonne-km																								✓	
SECURITY	Type of allocation requested	Traffic	Transport contract (number of trips requested)					✓																				
		Transport	According to the number of people and per trip					✓																				
	Type of service	Field of service	Type of traffic (Distinction passengers/freight)																							✓		
	Service offered (runs)	Route	Km covered (Total length)					✓																				
CONGESTION	Service offered (runs)	Route	Km covered (Total length)															✓										
		Performance indicator	Performance regime/delay/ minutes															✓										
			Saturation, temporary and local bottlenecks		✓																							

Remarks: Greek, Irish and Lithuanian rail charging systems not available in 2006; Estonian and Hungarian charging systems could not be interpreted since they were only published in the official language of the respective country

FIGURE 2.7 VARIABLES USED TO DEFINE THE CHARGE TO BE ASSIGNED TO COST CATEGORIES "ACCESS" AND "CAPACITY RESERVATION" DETECTED IN THE EUROPEAN IM'S NETWORK STATEMENTS

Source: Author's elaboration with data from the network statements valid in the year 2006.



2.2. THOUGHTS ON THE CHARGE FOR THE USE OF RAILWAY INFRASTRUCTURE INTRODUCED IN THE EUROPEAN UNION COUNTRIES

In 1998, ECMT (1998) considered that the introduction of charges for the use of railway infrastructure should be seen as a powerful tool for strengthening railways for facing competition from other modes of transport. This might be explained by the fact that charges for the use of railway infrastructure are not only aimed at covering costs, but they exert as well a strong influence in the way infrastructure is used, especially when railway undertakings are competitive (Thompson et al, 2006). A good such example is Thalys[48], which had to reduce its number of trains due to an increase in rail infrastructure charges, with the aim of raising the load factor and, consequently, the revenues per train in order to render Thalys services profitable again.

The preceding example backs Nash et al (2005) stating that a very important aspect of transport pricing is the final price to consumer, since this price is the one that determines railways competitiveness compared to other transport modes. Therefore, especially for journey times comprised between 3 and 4 hours, demand sensibility to ticket fares hints that a raise in the charge for the use of rail infrastructure or simply too high a charge can have a non-negligible effect on high speed railways – airways modal split. The level of charges is, as a result of that, crucial to establish a competitive high performance railway network.

According to the Developing European Railways Committee (DERC, 2005), rail infrastructure charges constitute an important part of a railway operator’s cost. Currently, it is known that high performance rail passenger services in Europe have to bear higher charges for the use of infrastructure than the other rail services, although no study has quantified the differences yet. As a first approximation, new high speed lines high construction costs and the fact that users are able and willing to financially contribute to the recovery of part of this cost, explain why charges are higher for high performance passenger services than for the rest of passenger services. Despite of that, in 2005 Nash et al (2005) indicated that for some years, there have been worries about the great variety in the level of charges having negative effects on the traffic volume in certain countries. In fact, in 2003, Moulinier (2003), member of the French Ministry of Equipment, already asked whether the structure of the charge for the use of railway infrastructure could handicap the future use of railway transport. It seems plausible that the great heterogeneity of charges, presented in the preceding section, are a sign that infrastructure managers are

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[48] Thalys International is a Belgian limited liability cooperative. It is a joint service offered by the Belgian (SNCB), French (SNCF), Dutch (NS) and German (DB) railways that provides commercial passenger rail transport services on their behalf between the following cities: Paris, Brussels, Amsterdam, Cologne.

far from the optimal charge value.

Given this situation, railway operators’ complaints on the level of charges are frequent (CER, 2005b). This fact, together with the preceding remarks, show the need for carrying out a quantitative study on the charges to be paid by railway operators that run high performance services on the European railway network in order to know in detail how the level of charge for the use of infrastructure may be affecting (or may affect) the present and future use of the European high speed railway network.

The interest of analysing the impact that charges for the use of infrastructure have on railway operators and users (that is, ultimately, on traffic volumes and mode split) of the lines composing the European high speed network is especially relevant in the current context, in which the reorganisation of the railway sector (which contributes to the establishment of a European market) will lead to an enlargement of the operating perimeter, especially suitable for high speed links between big cities (Bergougnoux, 2000), and in which the European Union is making big efforts into building a high performance European railway network aimed at fostering railways and favouring a modal re-equilibrium, main objective of the White Book published by the European Commission, entitled “European transport policy for 2010: time to decide”. What would be the point of devoting a great economical effort building a high performance railway network at European level if the charge for the use of the infrastructure penalised high performance railway transport with regard to possible competitor modes?

2.3. INTENDED RESEARCH. FORMULATION OF THE PHD OBJECTIVE

On the basis of what has been presented in section 2.2, the objective of the research is to determine the impact that the levels of charges set by rail infrastructure pricing systems in Europe exert on the high speed railways market position. In other words, the intended research aims at answering the following question:

> *“Which consequences do current levels of rail infrastructure charges implemented in the European framework have on the competitiveness of the high performance passenger services that run on the European railway network?”*

That is, the global objective of this PhD Thesis consists in analysing whether the current charging system for the use of railway infrastructure contributes or not to the development of high speed railways in Europe.

CHAPTER 3

METHODOLOGY AND BASIC ASSUMPTIONS

3.1. APPROACH AND STRUCTURE OF THE RESEARCH

Answering the question raised by the proposed research ("Which consequences do current levels of rail infrastructure charges implemented in the European framework have on the competitiveness of high performance passenger services that run on the European railway network?") requires to establish the possible correlation existing between a change in the rail infrastructure charge value and a change in the market share.

The changes in the level of rail infrastructure charges correspond, basically, to a:

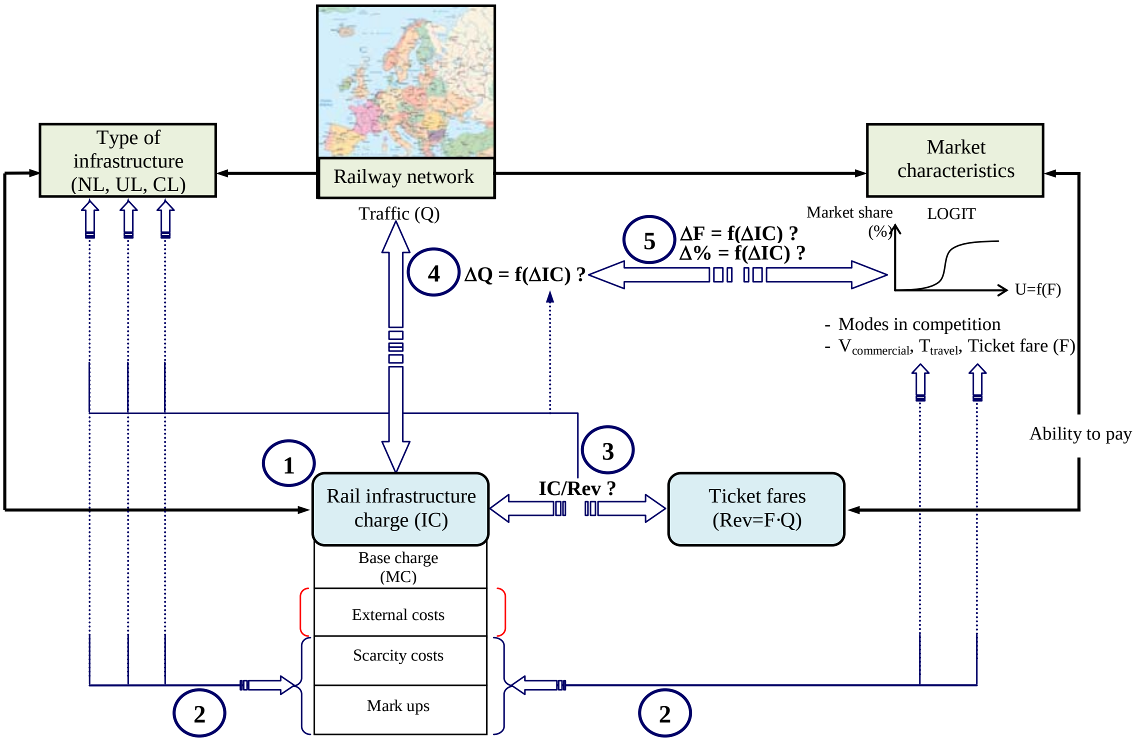
- *Change in the level of rail infrastructure charges up to making it equal to the marginal cost*: What would happen if high speed lines were charged at the marginal cost without mark ups?

- *Change in the level of rail infrastructure charges up to making it equal to the optimal charge* (calculated in chapter 1): Are the mark ups applied by pricing systems to high speed lines too high? Do they damage the development of high performance services or, on the contrary, do they benefit their development?

The determination of the abovementioned changes requires a good knowledge of the pricing systems implemented in the European railway framework, both of their structure and level. It requires as well a detailed characterisation of the pricing specificities for (new or upgraded) high speed lines. In this line, it is essential to carry out a detailed analysis about how mark ups above marginal cost have been established (if they actually exist).

With regard to the establishment of a correlation between the rail infrastructure charge and the mode split, market share models such as Logit allow establishing a link between ticket fares and market share. However, the existing correlation between the level of rail infrastructure charge and ticket fares, which would allow relating the rail infrastructure charge with the market share, is up to this day still unknown.

FIGURA 3.1 RESEARCH APPROACH



LEGEND:

① *Sub-objective 1 – To detect the application of mark ups above marginal cost in the charging systems for European railway networks with high speed lines in operation*: Analysis of the charging systems, stressing the charging principles applied, the application of mark ups and the unit rates established for high speed services.

② *Sub-objective 2 – To come to a conclusion on the criteria for applying mark ups in the pricing systems implemented in the European railway network*: Development of an econometric analysis aimed at establishing correlations between rail infrastructure charges and the type of infrastructure, as well as market characteristics.

③ *Sub-objective 3 – To establish a link between the level of rail infrastructure charges and the revenues from ticket sales*: Previous stage to the establishment of the probable link existing between a change in the level of the rail infrastructure charge and the traffic level.

④ *Sub-objective 4 – To quantify the impact that the level of charges (or mark ups above marginal cost) implemented in the European railway network can be exerting on the traffic level in high speed and high performance lines*: To establish a link between a change in the level of rail infrastructure charges (or the level of mark ups above marginal cost) and a change in the rail traffic volume.

⑤ *Sub-objective 5 – To quantify the impact that the level of charges (or mark ups above marginal cost) implemented in the European railway network can be exerting on the high speed railways-airways mode split*: To establish a link between a change in the level of rail infrastructure charges (or the level of mark ups above marginal cost) and a change in the rail market share.

On the basis of the preceding remarks, the global objective of the proposed research has been divided into 5 sub-objectives. All of them are characterised overleaf (in chronological order) and schematised in **figure 3.1**:

(1) Sub-objective 1: *To detect the application of mark ups above marginal cost in the charging systems applied in European railway networks with high speed lines in operation*: Analysis of the charging systems, stressing the charging principles applied, the application of mark ups and the unit rates established for high speed services.

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(2) Sub-objective 2: *To come to a conclusion on the criteria for applying mark ups in the pricing systems implemented in the European railway network*: Development of an econometric analysis aimed at establishing correlations between rail infrastructure charges and the type of infrastructure, as well as market characteristics.

(3) Sub-objective 3: *To establish a link between the level of rail infrastructure charges and the revenues from ticket sales*, as a previous stage to the establishment of a probable link connecting a change in the level of the rail infrastructure charge with the traffic level.

(4) Sub-objective 4: *To quantify the impact that the level of charges (or mark ups above marginal cost) implemented in the European railway network may be exerting on the traffic level in high speed and high performance lines*: To establish a link between a change in the level of rail infrastructure charges (or the level of mark ups above marginal cost) and a change in the rail traffic volume.

(5) Sub-objective 5: *To quantify the impact that the level of charges (or mark ups above marginal cost) implemented in the European railway network may be exerting on the high speed railways-airways mode split*: To establish a link between a change in the level of rail infrastructure charges (or the level of mark ups above marginal cost) and a change in the rail market share.

Chapters 4, 5 and 6 deal with these five sub-objectives.

Chapter 4, "Analysis of the structure and value of rail charges for the use of rail infrastructure in the European high speed network", is devoted to the achievement of sub-objectives 1 and 2. In this chapter the charging systems implemented in the European countries with high speed lines in operation are analysed in detail. Special emphasis is put on the pricing principles applied, the characterisation of the application of mark ups above marginal cost and unit tariffs for high speed services running on new lines (NL), upgraded lines (UL) and conventional lines (CL). An econometric analysis aimed at establishing a correlation between rail infrastructure charges implemented in the European high performance railway network and the type of infrastructure (NL, UL, CL), as well as market characteristics (commercial speed, travel time), is also developed in chapter 4.

Chapter 5, “Analysis of the link between rail charges for the use of infrastructure and rail revenues from the ticket sales”, deals with sub-objective 3.

Finally, chapter 6, “Analysis of the impacts that current prices charged to high speed trains are likely to have on high speed railways competitiveness”, focuses on sub-objectives 4 and 5.

The tasks needed to achieve the sub-objectives require defining a methodology and a series of assumptions in order to:

- Define the geographical framework to be analysed, including the modelling of the network to be analysed and the description of the competition framework in this network.
- Calculate the rail infrastructure charges and the railways’ revenues in the set of links that constitute the network being studied.
- Calculate the charges and revenues of the rival mode of transport in the set of links that define the network being studied[49].
- Define a theoretical link between the level of rail infrastructure charge and the rail traffic volume.
- Define a theoretical link between the level of rail infrastructure charge and the ticket fare rates for travelling by rail.
- Define a market share model that sets up the link between the rail ticket fare rate and the rail market share.

Next section presents the methodology and the basic assumptions (relative to the abovementioned points) taken for this piece of research.

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[49] The interest in calculating these parameters for the rival mode lies in being able to thoroughly study the link existing between the amount of rail infrastructure charges and the railways undertakings’ revenues from ticket sales for high speed services compared to the one registered for conventional services and to thouroughly study the possible consequences for the competitiveness of high performance services with regard to its main competitor mode of transport.

3.2. MODELLING OF THE ANALYSED NETWORK AND DEFINITION OF THE COMPETITION FRAMEWORK

3.2.1. Definition of the geographical framework to be analysed

The geographical framework defined for carrying out the proposed research is the one comprised by the EU-25 countries (except for Cyprus and Malta, since they do not currently have a railway network), as well as Norway and Switzerland. Within the area considered, the infrastructure management is undertaken by the rail infrastructure managers listed in **figure 3.2**.

3.2.2. Modelling of the network to be analysed

As detailed in annex A1, the current proposal of European high speed railways network combines completely new high speed lines with upgraded lines for raising speeds up to the 200-250 km/h benchmark, as well as with existing lines that play a linking and spreading role.

As a result of the fact that the future high speed railway network will be constituted by three different types of infrastructure (new lines, upgraded lines and conventional lines), all new high speed lines in operation, upgraded lines and conventional lines (that in a closer or further future will be, or not, substituted by new infrastructures or upgraded infrastructures) were taken into consideration for the modelling of the high performance railway network.

The consideration of this heterogeneity in the nature of the infrastructure, not only fits in the nature of the future high performance railway network, but it also allows a more complete characterisation of the mark ups above marginal cost implemented by pricing systems. The range of their variability contingent on commercial speeds and the travel time will indeed be higher.

The high performance railway network has been modelled with 100 Origin-Destination links (ODs from now on): 25 national main links (one per country) and 75 (national and international) European links, representative of the European high performance railway network. They have been selected according to the criteria presented in **table 3.1**.

FIGURE 3.2 GEOGRAPHICAL FRAMEWORK AND RAIL INFRASTRUCTURE MANAGERS IN THE TERRITORY CONSIDERED

Country	Infrastructure manager
DE	Deutsche Bahn Netz AG (DB Netz)
AT	ÖBB Infrastruktur Betrieb
BE	Infrabel
DK	Banedanmark
SK	Železnice SR
SI	Javna agencija za železniški promet Republike Slovenije (AŽP)
ES	Administrador de Infraestructura Ferroviaria (ADIF)
EE	Raudteeinspektsioon
FI	Ratahallintokeskus Banforvaltningscentralen
FR	Réseau Ferré de France (RFF)
EL	OSE S.A.
NL	ProRail B.V.
HO	MÁV Rt
IE	Iarnród Éireann

Country	Infrastructure manager
IT	Rete Ferroviaria Italiana SpA (RFI)
LV	Latvijas Dzelzcelsh (LDZ)
LT	Lietuvos Gelezinkelai (LG)
LU	Société Nationale des Chemins de Fer Luxembourgeois (CFL)
NO	Jernbaneverket (JBV)
PL	PKP Polskie Linie Kolejowe S.A.
PT	REFER EP
UK	Network Rail
CZ	Správa Železnični Dopravní Cesty (SŽDC)
SE	Banverket
CH	Schweizerische Bundesbahnen (SBB)
	BLS
	Regionalverkehr Mittelland (RM)

TABLE 3.1 SELECTION CRITERIA FOR THE EUROPEAN LINKS (NATIONAL AND INTERNATIONAL) TO MODEL THE EUROPEAN HIGH PERFORMANCE RAILWAYS NETWORK

Selection criteria for the 100 European links
✓ - Origin/destination link through which high speed trains currently run or - Origin/destination link with a high speed line under construction or - Origin/destination link with a high performance line in operation
✓ - Link identified in the high speed network map defined by the International Union of Railways (UIC)[50] for the 2020 horizon (see appendix A1, **figure A1.10**) and/or - Potential high speed link in the CEEC[51] described in the study “The opportunity for high speed railways in the CEEC” (CENIT, 2004, for UIC)
✓ For the 75 (national and international) European links, representative of the European high performance railway network, links distributed in the following distance segments, taking into consideration that high speed railways competitiveness is stronger for links allowing travel times shorter than 3 hours: ▪ [0 ; 250 km] ▪ [250 km ; 600 km] ▪ [600 km ; 1.000 km] ▪ [1.000 km ; 1.500 km] ▪ [> 1.500 km]
✓ Geographical and national equilibrium criteria in order that the selected links can be considered to be representative of the European railway network

As a result of these criteria, the 100 links selected as representative of the European high performance railways network are the ones schematised in **figure 3.3** and defined in **tables 3.2** and **3.3** according to the characteristics that they had in 2006. It has to be highlighted that out of the 100 links, 49 are national links, while 51 are international links (see **table 3.4**). In addition, 27 links cross one border, 16 links cross two borders and 8 links cross three or more borders.

TABLE 3.2 LINKS SELECTED AS NATIONAL MAIN LINKS OF THE EUROPEAN HIGH PERFORMANCE RAILWAY NETWORK (1 PER COUNTRY)

Country	Link	Distance	$V_{commercial}$ (km/h)
1. Germany	Frankfurt – Köln	180	154
2. Austria	Wien – Salzburg	317	123
3. Belgium	Bruxelles – Liège	103	121

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[50] Founded in 1922, the International Union of Railways (UIC– Union Internationale des Chemins de fer) is the worldwide international organisation of the railway sector (www.uic-asso.fr).

[51] CEEC: Central and Eastern European Countries.

Country	Link	Distance	$V_{commercial}$ (km/h)
4. Denmark	København – Esbjerg	319	112
5. Slovak Republic	Bratislava – Zilina	196	81
6. Slovenia	Ljubljana – Maribor	156	87
7. Spain	Madrid – Sevilla	471	202
8. Estonia	Tallin – Narva	210	70
9. Finland	Helsinki – Turku	200	112
10. France	Paris – Lyon	433	234
11. Greece	Athinai – Thessaloniki	502	118
12. Netherlands	Amsterdam – Breda	132	76
13. Hungary	Budapest – Debrecen	221	87
14. Ireland	Belfast – Dublin	183	95
15. Italy	Roma – Firenze	261	167
16. Latvia	Riga – Recekne	224	69
17. Lithuania	Vilnius – Klaipeda	376	80
18. Luxemburg	Belgian border – French border (via Kleinbettingen-Luxembourg-Bettembourg)	36	213
19. Norway	Oslo – Trondheim	553	84
20. Poland	Warszawa – Katowice	319	128
21. Portugal	Lisboa – Porto	337	116
22. United Kingdom	London –Newcastle	432	162
23. Czech Republic	Praha – Brno	256	107
24. Sweden	Göteborg – Stockholm	457	159
25. Switzerland	Genève – Lausanne – Berne – Zürich	295	109

TABLE 3.3 LINKS SELECTED AS (NATIONAL AND INTERNATIONAL) EUROPEAN LINKS, REPRESENTATIVE OF THE EUROPEAN HIGH PERFORMANCE RAILWAY NETWORK

Link	Distance segment	Commercial speed (km/h)
26. København – Malmö	[0-250]	82
27. Madrid – Toledo	[0-250]	150
28. Bratislava – Wien	[0-250]	58
29. Lille – Bruxelles	[0-250]	203

Link	Distance segment	Commercial speed (km/h)
30. Warszawa – Lódz	[0-250]	60
31. Manchester - Birmingham	[0-250]	82
32. Praha – Ostrawa	[250-600]	83
33. Ljubljana – Trieste	[0-250]	53
34. Milano – Genova	[0-250]	102
35. Lyon – Genève	[0-250]	98
36. Strasbourg – Stuttgart	[0-250]	91
37. Paris – Tours	[0-250]	186
38. Paris – Lille	[0-250]	217
39. Roma – Napoli	[0-250]	160
40. Amsterdam – Bruxelles	[0-250]	89
41. Hannover – Berlin	[250-600]	161
42. Wien – Nürnberg	[250-600]	126
43.Warszawa – Poznan	[250-600]	112
44. Madrid – Zaragoza	[250-600]	205
45. Firenze – Milano	[250-600]	115
46. Lyon – Marseille	[250-600]	229
47. Warszawa – Gdansk	[250-600]	75
48. Hannover – Frankfurt	[250-600]	160
49. Bruxelles – Köln	[0-250]	99
50. Paris – Rennes	[250-600]	160
51. London – Bruxelles	[250-600]	175
52. Warszawa – Wrocław	[250-600]	56
53. Praha – Berlin	[250-600]	79
54. Bratislava – Košice	[250-600]	70
55. Praha – Wien	[250-600]	92
56. Amsterdam – Berlin	[600-1000]	99
57. Paris – Strasbourg	[250-600]	197
58. Paris – Amsterdam	[250-600]	132
59. Paris – Genève	[250-600]	162
60. Warszawa – Berlin	[250-600]	100
61. Paris – Bordeaux	[250-600]	183

Link	Distance segment	Commercial speed (km/h)
62. Praha – München	[250-600]	90
63. Stockholm – Oslo	[250-600]	96
64. Madrid – Barcelona	[600-1000]	149
65. London –Edinburgh	[250-600]	123
66. Lisboa – Madrid	[600-1000]	70
67. Barcelona – Bordeaux	[600-1000]	72
68. Barcelona – Lyon	[600-1000]	106
69. Oslo – København	[600-1000]	85
70. Warszawa – Wien	[600-1000]	96
71. Paris – Marseille	[600-1000]	249
72. Paris – Hannover	[600-1000]	113
73 København – Köln	[600-1000]	89
74. Strasbourg – Nürnberg	[600-1000]	67
75. Milano – Köln	[600-1000]	94
76. London – Strasbourg	[600-1000]	101
77. München – Roma	[600-1000]	86
78. Hamburg – Stockolm	[600-1000]	97
79. Amsterdam – Warszawa	[1000-1500]	85
80. London – Bordeaux	[1000-1500]	146
81. Genève – Wien	[1000-1500]	90
82. Barcelona – Sevilla	[1000-1500]	158
83. Barcelona – Paris	[1000-1500]	97
84. Hamburg – Wien	[1000-1500]	124
85. Lisboa – Barcelona	[1000-1500]	80
86. Marseille – Amsterdam	[1000-1500]	157
87. Praha – Paris	[1000-1500]	87
88. Paris – Wien	[1000-1500]	86
89. Luxembourg – Warszawa	[1000-1500]	103
90. Paris – Roma	[1000-1500]	101
91. Glasgow – Rennes	[1000-1500]	119
92. Paris – Warszawa	[> 1500]	107
93. Zürich – Warszawa	[> 1500]	69

Link	Distance segment	Commercial speed (km/h)
94. Madrid – Zürich	[> 1500]	96
95. München – Stockolm	[> 1500]	105
96. Madrid – Bruxelles	[> 1500]	111
97. London – Warszawa	[> 1500]	83
98. Barcelona – Wien	[> 1500]	84
99. Lisboa – Genève	[> 1500]	70
100. Madrid – Wien	[> 1500]	86

FIGURE 3.3 LINKS SELECTED AS REPRESENTATIVE OF THE EUROPEAN HIGH PERFORMANCE RAILWAY NETWORK

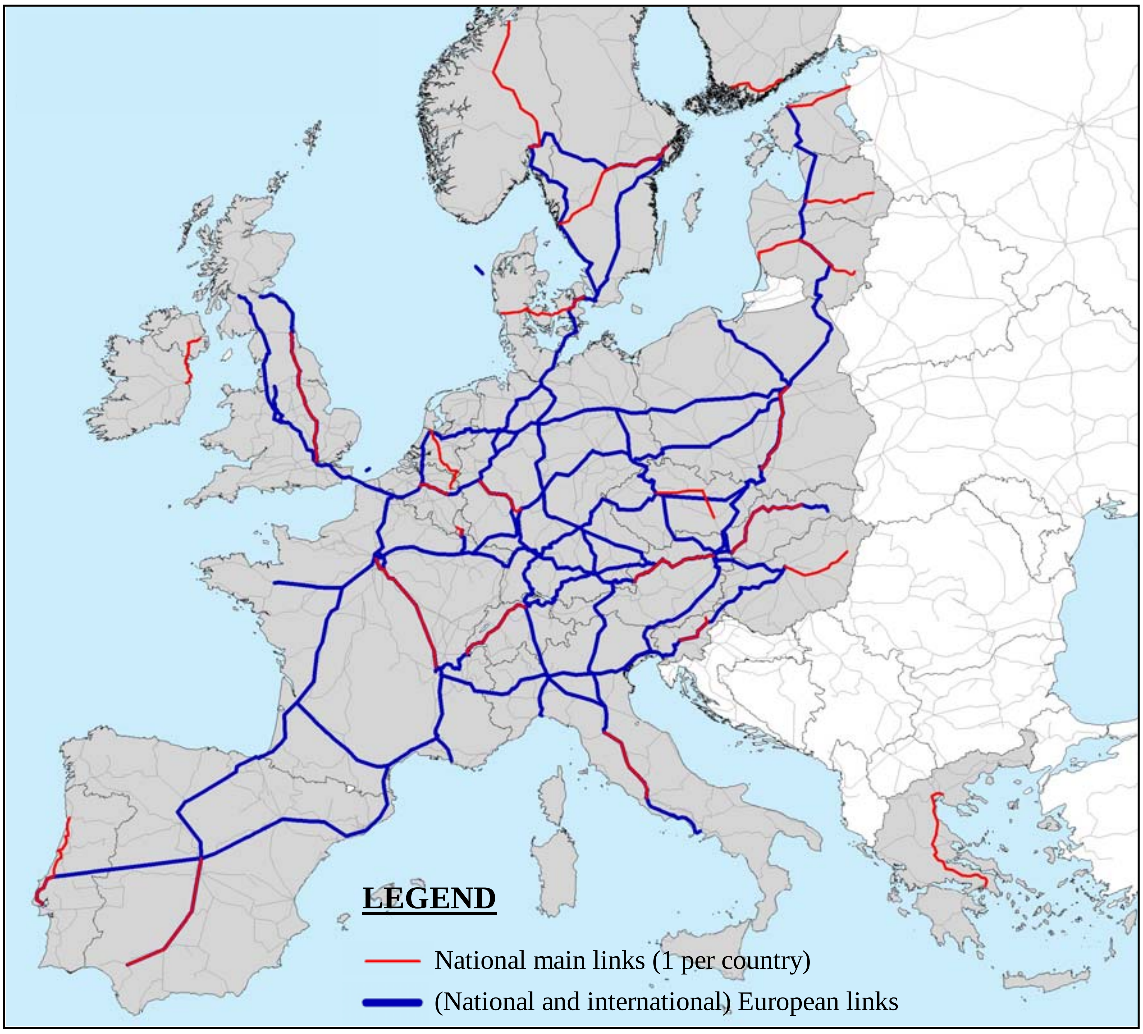

TABLE 3.4 CHARACTERISTICS OF THE SELECTED LINKS

Distance segment	National links	International links
[0-250]	18	8
[250-600]	28	9
[600-1000]	2	13
[1000-1500]	1	12
[> 1500]	0	9
TOTAL	49	51

3.2.3. Description of the competition framework

Within the geographical framework defined in the preceding section, high performance railways compete with airways and/or the road. However, in this piece of research, the analysis of the competitiveness of high performance passenger services that run on the European high speed network has been restricted to the high speed railways-airways competition framework.

3.3. METHODOLOGY AND ASSUMPTIONS FOR THE CALCULATION OF THE RAIL INFRASTRUCTURE CHARGES APPLIED TO THE EUROPEAN HIGH SPEED NETWORK

In this section the sources of information and the tools available for the calculation of rail infrastructure charges in European railway networks are analysed. A methodological proposal for the calculation of rail infrastructure charges is presented.

3.3.1. Sources of information and tools available for the calculation of rail infrastructure charges in European railway networks

There are different sources of information and public tools to calculate rail infrastructure charges in the European networks. The most relevant ones are:

- Network statements and other public documents on railway infrastructure pricing (decrees, laws, …).

- EICIS, a tool for the calculation of rail infrastructure charges.

The next sections are devoted to characterising them.

3.3.1.1. The Network Statements

As presented in chapter 1, a Network Statement is, by definition of Directive 2001/14/EC, “the statement that sets out in detail the general rules, deadlines, procedures and criteria concerning the charging and capacity allocation schemes” and that contains “such other information as is required to enable application for infrastructure capacity” as well.

According to the aforementioned Directive, the Network Statement should provide the information summarised in **table 3.5**.

With the aim of designing a common guideline for the elaboration of Network Statements, including a common format and structure, UIC’s infrastructure managers established a working group in 2002. This working group gave rise to a formal agreement amongst all EU infrastructure managers on the Network Statement’s format. Current Network Statements have been elaborated according to the agreed format. The information they contain is generally structured into seven chapters, namely:

- Chapter 1. General information: amongst the most important information of this chapter, one can find the legal framework of the Network Statement, as well as its validity.

- Chapter 2. Conditions of access: this chapter describes which traffic and under which conditions (security conditions, request of capacity, commercial) may have access to the network, as well as the technical requirements that the rolling stock and the railway staff should fulfill.

- Chapter 3. Description of the network/infrastructure: this section cotains, amongst other information, details on the network performances (gauge, load per axle, linear load, tonnage rating, characteristic gradients, maximal speed, etc.), the safety systems, traffic control and communications, traffic restrictions and availability of the infrastructure.

- Chapter 4. Capacity allocation: this chapter describes the process of a train-path request.

TABLE 3.5 CONTENTS OF THE NETWORK STATEMENT ACCORDING TO DIRECTIVE 2001/14/EC
Source: Own from CE (2001d)

Contents
✓ A section setting out: ▪ The nature of the infrastructure which is available to railway undertakings ▪ The conditions of access to the infrastructure ✓ A section on charging principles and tariffs: ▪ Appropriate details of the charging scheme ▪ Sufficient information on charges that apply to the services listed in annex II (1) which are provided by only one supplier. ▪ Detail of the methodology, rules and, where applicable, scales used for the application of Article 7(4) and (5) (2) and Articles 8(3) and 9(4) . ▪ Information on changes in charges already decided upon or foreseen. ✓ A section on the principles and criteria for capacity allocation: ▪ Setting out of the general capacity characteristics of the infrastructure which is available to railway undertakings. ▪ Setting out of any restrictions relating to the use of the infrastructure, including likely capacity requirements for maintenance. ▪ Specification of the procedures and deadlines which relate to the capacity allocation process. ▪ Specific criteria which are employed during the capacity allocation process.

Remarks:

(1) Annex II of Directive 2001/14/EC refers to the services to be supplied to the railway undertakings. Those services are:

- *Services comprised within the minimum access package*: handling of requests for infrastructure capacity; the right to utilise capacity which is granted; use of running track points and junctions; train control including signalling, regulation, dispatching and the communication and provision of information on train movement; all other information required to implement or operate the service for which capacity has been granted.
- *Track Access to services facilities and supply of services*: use of electrical supply equipment for traction current, where available; refuelling facilities; passenger stations, their buildings and other facilities; freight terminals; marshalling yards; train formation facilities; storage sidings; maintenance and other technical facilities.
- *Additional services*: they may comprise traction current; pre-heating of passenger trains; supply of fuel, shunting, and all other services provided at the access services facilities mentioned above; tailor-made contracts for control of transport of dangerous goods and assistance in running abnormal trains.
- *Ancillary services*: they may comprise access to telecommunication network; provision of supplementary information; technical inspection of rolling stock.

(2) Relative to the inclusion of a charge which reflects the scarcity of capacity (section 4 of Article 7) and the cost of the environmental effects caused by the operation of the train (section 5 of Article 7).

(3) Relative to the exceptions to charging principles.

(4) Relative to the discounts.

- Chapter 5. Services: this chapter is devoted to presenting the services comprised within the minimum access package, as well as the additional, supplementary and ancillary services.

- Chapter 6. Charges: This chapter comprises a section devoted to the legal framework and presents the charging system, as well as the unit tariffs for the provision of services and the payment procedure.

- Chapter 7. Annexes: the annexes complement the information presented in the previous chapters of the network statement. Maps or lists with the segmentation of the infrastructure in charging terms are some of the contents of these annexes.

With the information contained in the chapter devoted to the charges and, in some cases, complemented with additional information presented in the annexes, it is possible to do a detailed calculation of rail infrastructure charges to be paid by a passenger train running on the tracks.

3.3.1.2. Other documents on the charging of European rail infrastructure

In addition to the network statements, in some countries other documents complementing the information on the charging system provided by the network statements exist. This is the case, for instance, of Italy, the Czech Republic and the United Kingdom.

In Italy, the charges and the method of calculation to be applied are published in different decrees. In the Czech Republic the charges are published by the Czech Ministry of Finances in a prices bulletin not included in the network statement. Finally, with regard to the British case, the information on the charging of the rail infrastructure is spread over several documents (more than five) published by the railway regulator ORR (Office of Rail Regulation).

The consultation of these documents is of special interest, since their contents complement the ones of the respective network statements.

3.3.1.3. The European Infrastructure Charging Information System: EICIS

EICIS stands for “European Infrastructure Charging Information System”. The main goal of this system, managed by RailNetEurope[52], is to enable easy access to the information on rail infrastructure charges for the European railway network. Specifically, EICIS is a

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[52] RailNetEurope (RNE) is an association set up by a majority of European rail Infrastructure Managers. Its main goal is to enable fast, easy access to European rail, as well as to increase the quality and efficiency of international rail traffic. Scherp (2002) defines RailNetEurope as a commercial cooperation system whose aim is to facilitate the provision of international services to railway operators.

tool prepared for carrying out the calculation of rail infrastructure charges for train-paths, stations fees and shunting fees.

In February 2008, EICIS included 17 European railway networks[53] (EICIS, 2008). These networks correspond to the ones managed by the Austrian, Belgian, Swiss, Czech, German, Danish, Spanish, Hungarian, Italian, Luxembourgian, Norwegian, Polish, Swedish, Finish, Slovak and Slovenian IMs.

EICIS has established four steps in the calculation of charges to be paid for running on the networks above:

- The **first step** requires specifying the **train category**, which distinguishes between freight trains, passenger trains and others (mail trains, military trains, etc.).

- The **second step** is devoted to the definition of the **train-path**. It requires characterising the origin and the destination of the route (country, infrastructure manager and origin and destination stations). There is also the possibility of specifying one or several intermediate points of the route and choosing between the calculation for the shortest or the cheapest route.

- The **third step** is devoted to the definition of the **train characteristics**. EICIS requires twelve inputs in order to define them: Type of train (high speed train, fast passenger train, slow passenger train, suburban train, lightweight train), type of traction (diesel, electric, steam), number of locomotives, number of cars, length of all locomotives (in metres), length of all cars (in metres), total number of seats, weight of all locomotives (in tones), weight of all cars/motor units (in tones), maximum axle load (in tones), path type (express path, short distance regular interval path, long distance regular interval path, economy passenger path, disposition path), supplement (no supplement or titling for passenger trains; axle load higher than 22 tones, out of gauge for freight trains and transport of dangerous goods). Besides that, four inputs are reserved in order to define the following special parameters: requested average speed, number of all diesel locomotives, number of all electric locomotives and number of all steam locomotives.

- Finally, the **fourth step** focuses on the **stations**. In this stage, the duration of the stop (expressed in minutes) is characterised.

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[53] The list provided by the programme comprises 22 countries. However, only 17 out of these 22 countries contain the data needed for the calculation of rail infrastructure charges. The other five countries correspond to Croatia, Portugal, France, Rumania and the United Kingdom.

Even if EICIS is a powerful calculation tool for international train-paths, it has several weak points that hinder the rail charges calculations accuracy. Amongst them we find:

- Firstly, **several countries have not introduced in the programme their information** on infrastructure charges. As a result of that, it is not possible to calculate the charges for runs taking place within or crossing those countries (France, Croatia, Portugal, Romania and the United Kingdom). The lack of data for France notably penalises the use of this tool for the analysis proposed, because of the great importance of the French high speed network and its strategic central setting affecting international services derived from the large number of countries bordering France: Spain, Italy, Germany, Luxembourg, Belgium and the United Kingdom.

- Secondly, **the programme's database is still under completion**, especially in the passenger transport framework. To give an example, in the Spanish network the calculation of the charge for the use of stations is still incomplete. This leads to the programme giving a charge equal to 0 euros, although the Spanish network statement actually defines a positive charge for the use of stations. According to the contacts made with EICIS' responsible, the quality of the data and the reliability of the results of the charges calculations strongly depend on the data manager appointed by each infrastructure manager and on the data that it introduces in EICIS.

- Even if the four steps to calculate charges defined by EICIS allow introducing a large number of **variables**, **in most cases these do not coincide with the ones defined in the network statements**. This results into EICIS giving only a rough calculation. To give an example, EICIS does not allow calculating charges for different time periods, as required by the Spanish, French, Italian and Belgian charging systems. On the contrary, some information requested by EICIS is not required by some European rail charging systems for the calculation of rail charges.

3.3.2. Proposal of a methodology to calculate rail infrastructure charges

Taking into account the considerations presented in the preceding sections, a methodology to calculate rail infrastructure charges has been proposed. It is based on:

- The selection of the documents to be used for calculating rail charges for passenger services.

- The elaboration of a charging database, based on the contents of the documents selected, in order to ease the charges analysis and calculation processes.
- The definition of the rail infrastructure charges calculation procedure

Next sections give details on these three points.

3.3.2.1. Documents used

The network statements for 2006 and the supplementary documents presented in **table 3.6** were the ones chosen as sources of information for the calculation of rail infrastructure charges. This choice was done taking into consideration the remarks made in the preceding sections on the information contained in the public documents on rail infrastructure charges (the network statements) and the characteristics of the rail infrastructure charges calculation tools available up to date.

TABLE 3.6 DOCUMENTS USED TO BUILD THE DATABASE ON RAIL INFRASTRUCTURE CHARGING

Country	Documents used	Validity period
✓ Germany	▪ Network Statement ▪ Products Train Paths. Modular Train Path Price System, 02/2005 ▪ Stationspreisliste 2006 ▪ Bahnhofskategorisierung der DB Stations+Service AG	11.12.05 – 10.12.06
✓ Austria	▪ Network Statement 2006 ▪ Track Access Product Catalogue 2005	11.12.05 – 10.12.06
✓ Belgium	▪ Document de Référence du Réseau 2006	11.12.05 – 09.12.06
✓ Denmark	▪ Network Statement 2006	11.12.05 – 09.12.06
✓ Slovak Rep.	▪ Network Statement (Ref. No. 1430/O410)	01.01.06 – 31.12.06
✓ Slovenia	▪ The Network Statement of the Republic of Slovenia 2007	10.12.06 – 08.12.07
✓ Spain	▪ Declaración sobre la Red 2006	11.12. 05 – 09.12.06
✓ Estonia(1)	▪ Network Statement 2006-2007	28.05.06 – 26.05.07
✓ Finland	▪ Network Statement 2006	11.12.05 – 09.12.06
✓ France	▪ Document de Référence du Réseau Ferré National. Horaire de service 2006	11.12.05 – 09.12.06
✓ Greece(2)	–	–
✓ Netherlands	▪ Network Statement 2006	10.12.05 – 09.12.06
✓ Hungary(1)	▪ Network Statement 2006	Up to 01.01.06
✓ Ireland(2)	–	–
✓ Italy	▪ Network Statement ▪ Decree of 21 March 2000, 22 March 2000, 11 April 2003, 15 July 2003 and 24 March 2005	12.12.04 – 12.09.06
✓ Latvia	▪ Network Statement 2006	29.05.05 – 28.05.06
✓ Lithuania(1)	–	–

Country	Documents used	Validity period
✓ Luxemburg	▪ Document de Référence du Réseau 2006	11.12.05 – 09.12.06
✓ Norway	▪ Network Statement 2006	2006
✓ Poland	▪ Cennik na rok 2006 ▪ "Cennika na rok 2006. Stawki jednostkowe opłat za usługi podstawowe udost_pniania linii kolejowych PKP Polskie Linie Kolejowe S.A."	10.12.05 – 09.12.06
✓ Portugal	▪ Network Statement 2005. 1st Addenda	2005
✓ U. Kingdom	▪ Schedule 7 : Track Charges ▪ Access Charges Review 2003 : Regulator's approval of network rail's proposed financing arrangements ▪ Railways Act 1993: Access charges review 2003 ▪ Track usage price list ▪ List of Capacity Charges Rates ▪ Schedule of CC terms	01.04.05 – 31.03.06
✓ Czech Rep.	▪ Network Statement (Ref. no. 6461/04- OŘ, and updates up to No. 3/2005) ▪ Price Bulletin of the Ministry of Finance of the Czech Republic 1/2005	From 01.07.05
✓ Sweden	▪ Network Statement T05.2	08.01.06 – 19.06.06
✓ Switzerland	▪ Network Statement. Infrastructure ▪ Catalogue de prestations Infrastructure 2006	11.12.05 – 09.12.06
SEGMENTS WITH SPECIAL CHARGING		
✓ Channel T.	▪ Eurotunnel's Network Statement ▪ Network Rail/Eurostar contract	14.12.03 – 11.12.04
✓ Öresund	▪ Document de Référence du Réseau 2006 ▪ Network Statement Part 1(2) *(20060108–20060619 (T05.2))*	2005 (Danish part) 08.01.06 – 09.12.06 (Swedish part)
✓ Storebælt	▪ Network Statement 2006 (Banedanmark)	2005

Remarks:

(1) The Estonian and Hungarian network statements of 2006 are only published in the official language of the respective country. Hence, their interpretation was not possible. For these countries and for Lithuania (country for which a network statement for the year analysed does not exist) the data used for the calculation of rail charges were obtained from CEMT (2005).

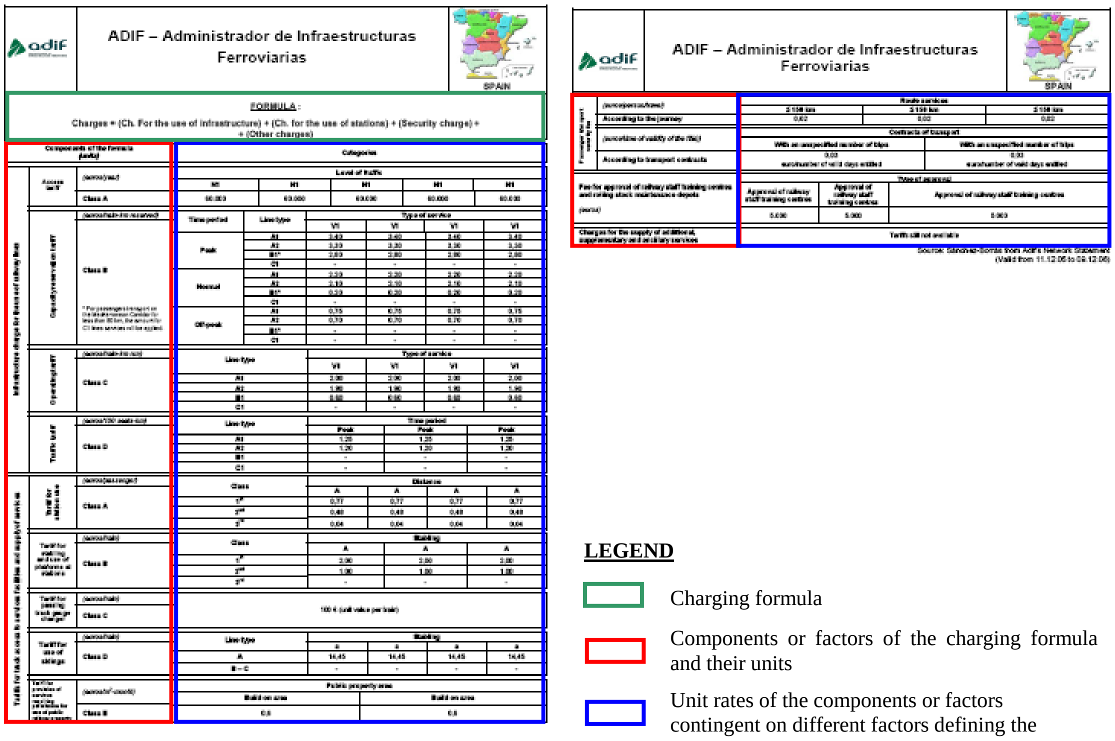
(2) Rail charging systems not available in 2006.

- The fares published in the documents presented in this table do not include VAT (value-added tax), which varies considerably from one country to another.

3.3.2.2. Development of a database

In order to facilitate the analysis of the rail charging systems and the calculations of rail infrastructure charges, a database was developed. This database gathers the charging information presented in the network statements and in the annexed documents that complement the charging information of the network statements presented in **table 3.6**. The interest of developing this database lies in several aspects:

FIGURE 3.4 EXAMPLE OF CARD CONTAINING THE INFORMATION OF THE PRICING LIST. SPANISH CASE



ADIF – Administrador de Infraestructuras Ferroviarias

SPAIN

FORMULA:

Charges = (Ch. For the use of infrastructure) + (Ch. for the use of stations) + (Security charge) + + (Other charges)

Source: Sánchez-Borràs from Adif's Network Statement (Valid from 11.12.05 to 09.12.06)

LEGEND

🟩	Charging formula
🟥	Components or factors of the charging formula and their units
🟦	Unit rates of the components or factors contingent on different factors defining the network, the traffic, etc.

- Synthesising and systematising the data on rail charging systems for the different European countries: The network statements have a common structure. However, they differ considerably with regard to the charging system adopted. This fact hinders the analysis and the comparison of the charging systems, as well as the systematisation of the calculations for the geographical framework analysed and, especially, the calculations of charges for international links. Hence, the interest of synthesising and systematising the data on charging systems for the European countries analysed, in order to present them in a clear, concise and comparable way.

- Speeding up the calculations of the rail infrastructure charges: Grouping the elements needed for the charges calculation in a single card per country considerably eases up the calculation, by allowing disregarding burdensome documents and directly focusing on the important information for the calculation.

- Standardising the language in which the data is presented: Even if the great majority of rail infrastructure managers currently publish their network statements in English, there are cases in which some information is only available in the official language of the country, sometimes because it is presented as an annex to the network statement. This is for instance the case of certain Italian decrees that complement the information of the network statement, of the Polish and Hungarian network statements, and of some Austrian and German documents. A preliminary task of translation facilitates the subsequent calculation task.

In annex A3 the basic information of the database necessary for analysing the charging systems and calculating the rail infrastructure charges is presented under a card format (see **figure 3.3**). This information corresponds to the rail charges unit tariffs applied in each European country, differentiating, as far as possible, between minimum access package, ancillary services, supplementary services, etc. and specifying the unit prices for each category or variable considered (type of line, train, station, traffic, time period, etc.).

3.3.2.3. Assumptions in the calculation of rail infrastructure charges for high performance services

To calculate European rail infrastructure charges in some cases is required, as seen in **figure 2.5** (in which the variables used by the European infrastructure managers are presented), to know the characteristics of the train running on the infrastructure, the time period in which runs take place and the stations in which the train stops. The assumptions made on their definition when calculating rail infrastructure charges in this piece of research are presented below. When analysing the results of the calculations it will be very important to bear them in mind.

Assumptions regarding the time period and the stops at stations

The assumptions made regarding the time period in which runs take place and the station in which the train stops have been summarised in **table 3.7**.

Given the complexity of the calculations of the rail charges in certain countries, and with the aim to simplify them, it was decided that only terminal stops would be considered. That is, calculations do not take into consideration the intermediate stops that a train makes in its current runs. This assumption means that the charges calculated will be, in those cases where the charging systems charge stops at stations, slightly lower than real charges. With regard to the Belgian case, especially for the TGV Bruxelles-Midi Terminal, this assumption can imply quite an important reduction of the charge value. This remark will be taken into consideration when analysing the results of the calculations.

The need to define the time period in which a given train runs comes from the fact that certain infrastructure managers charge differently runs at peak hours than at normal and off-peak hours. In the geographical framework of this research, only four infrastructure managers have introduced a charging system that distinguishes between time period: Adif in Spain, RFF in France, RFI in Italy and Infrabel in Belgium.

TABLE 3.7 ASSUMPTIONS REGARDING THE CALCULATION OF RAIL INFRASTRUCTURE CHARGES

Assumptions regarding…..	Assumptions made
✓ Rail charges calculation	
▪ For national links of reference (25 ODs)	→ Average between: - A train departing at 8 a.m. from the Origin point (O) towards the Destination point (D) - A train departing at 8 a.m. from the D to O - A train departing at 6 p.m. from the O to D - A train departing at 6 p.m. from the D to O
▪ For (national and international) European representative links (75 ODs)	→ Rail charge to be paid by a train departing at 8 a.m. from the Origin point (O) towards the Destination point (D)
✓ Stops at stations	→ Only terminals have been considered (intermediate stops not considered)
✓ Rates of exchange	→ With the aim of being able to compare all the costs, the rates of exchange valid in January 16, 2006(1) have been used (it is reminded that the rail charges analysed are the ones valid for 2006 in the different European national railway networks)

Remarks:

(1) The rates of exchange valid on the 16th of January 2006 are presented in annex A4.

In a first stage, the assumptions were defined for the 25 national main links of the European high performance railway network (defined in **table 3.2**). With the aim of analysing the influence of time differentiation in the amount of charges, for a given link both running directions were considered (O-D and D-O). At the same time, given their relatively short length and their relatively short travel times from the Origin point to the Destination point, it was supposed that both outward and return journeys would take place on the same day, the former taking place at 8 a.m. and the latter at 6 p.m. These timetables seem reasonable for business trips at a national level.

The calculations made by the author for the Spanish, French, Italian and Belgian national links allow stating that the difference between the infrastructure charge to be paid for a run linking O and D at 8 a.m. and the infrastructure charge resulting from the average of the four options presented in the preceding paragraph is practically negligible. This is due to the fact that according to the timetable assumptions made, in both running directions departures take place at peak periods and arrivals take place at normal or off-peak periods. Consequently, for the rest of the links analysed in this piece of research, it was considered appropriate and sensible to reduce (and therefore simplify) the calculation of the infrastructure charge to a single running direction (from O to D) and the outward journey. This simplification has a negligible impact on the resulting charge for the type of runs analysed in this piece of research.

It has to be mentioned that in some of the 100 selected links there are no railway services with departures at 8 a.m. However, in order to be able to compare infrastructure charges under the same conditions in the links where charging systems consider the timetable period, in such cases "fictitious" runs departing at 8 a.m. o'clock were considered. Despite this consideration, it is important to highlight that current trains' real routes linking O with D have been considered for the definition of the route covered by the trains running through the selected ODs. The information on this subject has been obtained from the *European Rail Timetable* (Cook, 2005).

Assumptions on the vehicle characteristics

A wide variety of trains (high speed or high performance trains) run on the European high performance railway network, from the French and "European" TGV (Thalys and Eurostar) to the German ICE, the Spanish AVE and the Italian ETR, amongst others.

TABLE 3.8 MOST PERFORMANT HIGH SPEED TRAINS IN OPERATION ON THE RAILWAY LINES IN THE EUROPEAN HIGH SPEED NETWORK (excluding regional high speed trains)
Source: Author's elaboration with data from RENFE (2008), Talgo (2007), Siemens (2006), Alstom (2006) and other sources

Model/Name	Company	Capacity (seats)	V_{max} (km/h)	Country and Year of 1st service
TGV Duplex	Alstom	350 to 520	300 a 320	France, 2006
ICE 3	Siemens	458		Germany, 2004 (series 2)
AVE S 102 (Talgo 350, "El Pato")	Talgo – Bombardier	?	330	Spain, 2001
AVE S 103	Siemens	404	330	Spain, 2003
ETR 485	Fiat Ferroviaria	?	320	Italy, 1990s

In **table 3.8** the data on capacity (number of seats) and maximal speed allowed by the most modern high speed trains that currently run on the national (and international) railway networks of the countries in which high speed infrastructure is more developed (in terms of total length built) has been summarised.

Taking into account that the analysis framework considered comprises the future high speed network, that the departure of the runs analysed takes place at the peak period and that currently the length of the French high speed network is the most important one within the European high speed network, it was decided to choose the TGV Duplex as the reference vehicle (see **figure 3.5**). **Table 3.9** summarises the characteristics of this train needed for the calculations to be carried out in this piece of research.

FIGURE 3.5 TRAIN CONSIDERED FOR THE CALCULATIONS: TGV DUPLEX
Source: Railway Technology (2008)

TABLE 3.9 ASSUMPTIONS RELATIVE TO THE CHARACTERISTICS OF THE RAILWAY VEHICLE

Characteristics of the railway vehicle			
Capacity	**Weight**	**Model selected**	**Other characteristics**
500 seats	430 tonnes (390 + 500 x 0,08)*	TGV Duplex	Single composition

Remarks:

* In the expression (390 + 500 x 0,08):
- 390 corresponds to the total weight of the empty train (expressed in tonnes);
- 500 corresponds to the number of seats;
- 0,08 corresponds to the average weight (expressed in tonnes) of a traveller.

3.3.2.4. Steps of the calculation procedure

On the line of the previous systematisation and harmonisation of the data relative to the European rail infrastructure charging, a common calculation procedure has been defined for all the European charging systems. It consists of four steps, presented by chronological order:

- First step: Link identification. In a first stage, it is necessary to identify the charging systems that apply to the calculation of the rail infrastructure charge for a given link. The more countries a given link crosses, that is, the more networks with a different owner it crosses, the higher the number of charging systems to be considered in the calculation procedure will be. This stems from the fact that, as it has been previously presented, each infrastructure manager applies a different charging system.

- Second step: Definition of the link. With the aid of the network statements, each link will have to be divided in segments, which will be characterised according to the type of line and/or other characteristics (such as the type of traffic, the weight of the train, the type of traction, the time period, the running speed, etc.), depending on the charging system applied to each segment.

- Third step: Calculation of each cost category. According to the structure of each network statement, rail infrastructure charges will be calculated by homogeneous groups (access charges, capacity reservation charges, charges for the use of stations, energy/electricity charges, etc.).

- Fourth step: Calculation of the total charges. The fourth and last step of the calculation procedure consists in adding the cost of each cost category in order to obtain the total charge to be paid by a high performance European railway service.

It is to be highlighted that the step devoted to the definition of the link is especially complicated in international links, since most network statements do not define the border segments in detail. In addition, defining a link implies, in certain cases, dividing the link into a high number of segments, over 200 in some cases.

3.4. METHODOLOGY AND ASSUMPTIONS FOR THE CALCULATION OF RAILWAYS’ REVENUES

The calculation of railway’s revenues requires knowing how much a passenger has to pay for its travel ticket, besides knowing the capacity and average load factor of the vehicle:

$$\textit{Railways' revenues} = (\textit{Capacity}_{train}) \times (\textit{Load factor}_{railways}) \times (\textit{Ticket price}_{railways}) \qquad \text{(f. 3.1)}$$

3.4.1. Determination of the average ticket fare for railways

The definition of the average ticket fare in a given railway link is essential for calculating Railway Undertakings' (RU) revenues.

Even if it is generally assumed that the average of the first and second class fares approaches the full fare of the second class, in reality, real revenues are lower than those calculated on the basis of the second class fare. This is a direct consequence of the existence of a wide range of discounts on full fares by means of seasonal tickets, special offers, etc. Therefore, it is not appropriate to calculate revenues on the basis of the full fare of the second class tariff.

Taking into account the preceding remarks, it was assumed that the average ticket fare for railways would be calculated as the ticket fare equivalent to 75% of the second class fare (obtained considering the return ticket), in order to take into account the considerable reductions offered by RUs to their customers:

$$\textit{Ticket price}_{railways} = (2^{nd} \textit{ class fare}) \times 0{,}75 \qquad \text{(f. 3.2)}$$

where the value of the second class fare corresponds to the price of a one-way ticket for travelling from O to D with a train departing at 8 a.m. (or around this period of the day). F 3.2 was validated by several stakeholders from different national RUs operating in Europe.

3.4.2. Determination of the load factor for railways

To determine the load factor for railways, real data concerning the load factors for Belgian, British, French and Spanish high speed trains has been consulted.

In Belgium, the average numbers of passengers per train for the trains running on the high speed network in 2003 were the ones presented in **table 3.10**. High speed trains' load factors in Belgium have been calculated assuming two different cases: services operated with no train set pairing and services operated in a two-train set pairing. If all Thalys services were operated in single train set pairing, their load factor would be 59,8% (see **table 3.10**). On the other hand, if Eurostar services were operated with the capacity of the Thalys trains and 50% of those services were operated in a two-train set pairing, the load factor of Eurostar services in Belgium would be 60,1%.

Concerning the traffic of Eurostar high speed trains crossing the Channel Tunnel, it reached 7,28 million passengers in 2004 and 7,45 million in 2005 (Eurotunnel, 2006).

With such traffics and the 750 seats configuration of Eurostar trains, the load factors amounted 53,2% in 2004 and 54,4% in 2005 (see **table 3.11**). These values, slightly above 50%, are rather low. This is the result of the undeformation of Eurostar train sets. If these services were operated with the capacity of a standard TGV Duplex (500 seats), one third of them in a two-train set pairing configuration, the load factor would reach 61,2%.

TABLE 3.10 LOAD FACTORS OF BELGIAN HIGH SPEED TRAINS IN THE YEAR 2003
Source: Sánchez Borràs from SNCB (2004) and Thalys (2008)

Train	Passengers/train (average year 2003)	Seats/train	Load factor
Eurostar	263,9	750	35,2%
Thalys	225,6	377(1)	59,8%
Thalys	225,6	501(2)	45,0%

Remarks:
(1) Assuming that there is no train set pairing
(2) Assuming a two-train set pairing

TABLE 3.11 LOAD FACTORS OF EUROSTAR HIGH SPEED TRAINS CROSSING THE CHANNEL TUNNEL IN 2004 AND 2005
Source: Sánchez-Borràs from Eurotunnel (2006)

Train	Passengers/train (average)	Seats/train	Load factor
Eurostar	399 (year 2004)	750	53,2%
Eurostar	408 (year 2005)	750	54,4%

In France, the average load factor in high speed trains (Eurostar and Thalys trains excluded) leaving from Paris was 67,6% in 2004. For the whole of TGV traffic (that is, including traffic that did not begin in Paris), the load factor was approximately 60% (SNCF, 2006[54]).

In Spain, the average load factor for the high speed market was 60,7% in 2004 (Renfe, 2005). This figure takes into account the load factors of the high speed links Madrid-Seville and Madrid-Barcelona, the latter being only partially in operation in 2004. Considering only the first Spanish high speed line (Madrid-Seville), the load factor reaches 66,1% (Renfe, 2004).

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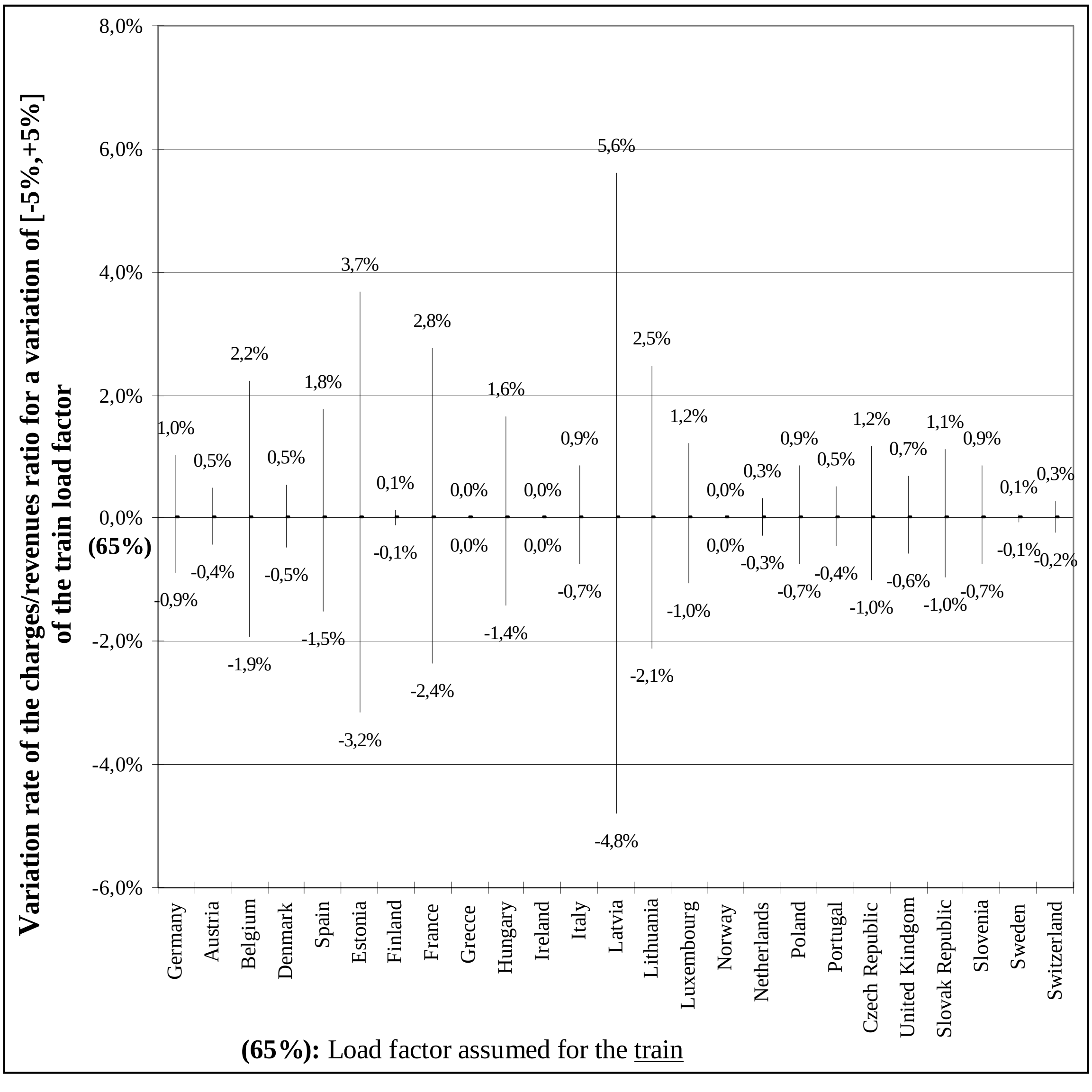
[54] These values were obtained from a direct contact with SNCF.

The average value of the load factor for the aforementioned sources is approximately 60%. Given the fact that, according to the assumptions on infrastructure charges calculations, the analysis will be made on hypothetical trains departing at 8 a.m. (peak hour) and that the values obtained from the abovementioned sources are average values for all time periods, the author decided to take a **load factor for railways** of **65%**. This value, which is intended to reflect the load factor of high speed trains in peak hours, remains nevertheless conservative. **Figure 3.6** shows the sensitivity analysis for a variation of (-5%, +5%) of the considered load factor (65%) on the value of the charges/revenues ratio, for the national links of reference presented in **table 3.2**.

FIGURE 3.6 SENSITIVITY ANALYSIS FOR THE LOAD FACTOR FOR HIGH SPEED TRAINS



(65%): Load factor assumed for the train

3.5. METHODOLOGY AND ASSUMPTIONS FOR THE CALCULATION OF CHARGES AND REVENUES FOR RAILWAYS' MAIN COMPETITOR: AIRWAYS

3.5.1. Methodology and assumptions for the calculation of airways' charges

If the calculation of rail infrastructure charges is a very complicated procedure, as it has been seen in section 3.3, the calculation of air charges is not a simpler task. This stems from the fact that, contrary to what happens in the railways' organisational structure, in the air sector not always does a single national organisation exist in charge of the establishing of the prices for all national airports.

Indeed, while for example in Spain a single national airport manager (AENA, *Aeropuertos Españoles y Navegación Aérea*) is in charge of the definition of air charges, in other countries such as for instance France, no such an organisation exists. In those countries each airport establishes its own charges for the use of the infrastructure.

Therefore, it is extremely difficult to gather the information on the precise charging regime applied in each European airport. Furthermore, the language of the charging documents can represent an added difficulty when trying to obtain the data on the subject at hand.

In order to overcome the aforementioned difficulties some assumptions on air charges calculation were made. Those are presented in the following sections.

3.5.1.1. Assumptions related to the calculation of air charges

It was assumed that air charges can be calculated as follows:

$$\text{Air charge} = (\text{Navigation charge}) + (\text{Passenger charge}) \qquad \text{(f. 3.3)}$$

where:

$$\text{Navigation charge} = \text{Route charge} + \text{Air Traffic Terminal Service Charge} \qquad \text{(f. 3.4)}$$

The **route charge** corresponds to the charge set aside for "remunerating the costs incurred by Eurocontrol[55] Member States for providing en-route services to the users of their airspace" (Eurocontrol, 2008). This charge takes into account the distance flown and, less

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[55] Eurocontrol is an agency whose mission is to harmonise and integrate air navigation services in Europe, aiming at the creation of a uniform air traffic management (ATM) system for civil and military users, in order to achieve the save, secure, orderly, expeditious and economic flow of traffic throughout Europe, while minimising adverse environmental impact (Eurocontrol, 2008).

than proportionately, the aircraft weight. The route charge per flight equals the sum of the charges generated in the Flight Information Regions (FIRs) of the individual States (i) concerned:

$$R = \sum_{i=1}^{n} r_i \tag{f. 3.5}$$

where r_i is the individual charge, which is equal to the product of a distance factor (d_i), a weight factor (p) and a unit rate (t_i):

$$r_i = d_i \times p \times t_i \tag{f. 3.6}$$

In (f. 3.6):

- The distance factor d_i is equal to the one hundredth of the great circle distance, expressed in kilometres, between the aerodrome of departure within (or the point of entry into) the airspace of the FIRs of State (i) and the aerodrome of first destination within (or the point of exit from) that airspace.

- The weight factor p corresponds to the square root of the quotient obtained by dividing by fifty the number of metric tons in the maximum certificated take-off weight (MTOW) of the aircraft as follows:

$$p = \sqrt{\frac{MTOW}{50}} \tag{f. 3.7}$$

- The unit rate t_i is established for each State and is applicable as from 1 January of each year. Nevertheless, it is adjusted every month in order to reduce the effect of exchange rate fluctuations on the system. The rates used for the calculations in this study were the adjusted unit rates applicable to January 2006 flights (see annex A5).

The **air traffic terminal service charge** (ATTSC) covers the cost of air traffic terminal services. Its value is equal to the product of a unit rate (u) and the number of service units (N):

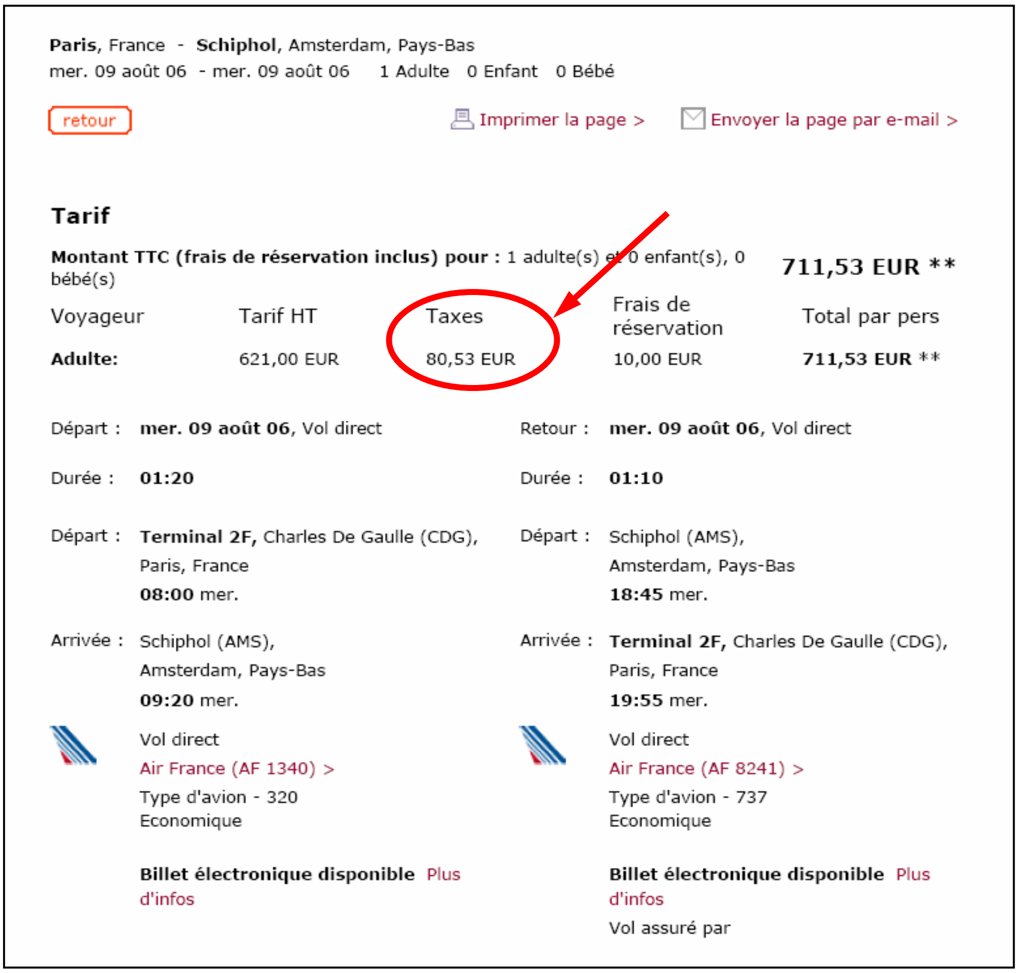
$$ATTSC = u \times N \tag{f. 3.8}$$

The values for the unit rate and the number of service units are published by each infrastructure manager. Given the aforementioned difficulties of gathering the information of the precise charging regime applied in each European airport, the values published by AENA (2005) where adopted for the calculations in all of the European airports considered in this dissertation. This implies that the number of service units is equal to the maximum take-off weight recorded in the flight manual of the aircraft expressed in metric tonnes raised to the power 0,90:

$$N = MTOW^{0,9} \qquad \text{(f. 3.9)}$$

With regard to the unit rate, the value considered was the one given by AENA (2005) for first category airports ($u = 4{,}41$).

FIGURE 3.7 EXAMPLE OF TAXES PAID BY EACH USER/CUSTOMER
Source: Opodo (2006)



Paris, France - **Schiphol**, Amsterdam, Pays-Bas
mer. 09 août 06 - mer. 09 août 06 1 Adulte 0 Enfant 0 Bébé

Tarif

Montant TTC (frais de réservation inclus) pour : 1 adulte(s) et 0 enfant(s), 0 bébé(s) 711,53 EUR **

Voyageur	Tarif HT	Taxes	Frais de réservation	Total par pers
Adulte:	621,00 EUR	80,53 EUR	10,00 EUR	**711,53 EUR** **

Départ : **mer. 09 août 06**, Vol direct

Durée : **01:20**

Départ : **Terminal 2F,** Charles De Gaulle (CDG),
Paris, France
08:00 mer.

Arrivée : Schiphol (AMS),
Amsterdam, Pays-Bas
09:20 mer.

Vol direct
Air France (AF 1340) >
Type d'avion - 320
Economique

Billet électronique disponible Plus d'infos

Retour : **mer. 09 août 06**, Vol direct

Durée : **01:10**

Départ : Schiphol (AMS),
Amsterdam, Pays-Bas
18:45 mer.

Arrivée : **Terminal 2F,** Charles De Gaulle (CDG),
Paris, France
19:55 mer.

Vol direct
Air France (AF 8241) >
Type d'avion - 737
Economique

Billet électronique disponible Plus d'infos
Vol assuré par

Finally, the **passenger charge** corresponds to the charge relating to travellers. Its value can be obtained from the flight tickets. As it can be seen in **figure 3.7**, each passenger must pay a tax. The value of the passenger charge for a given flight covering an OD link, will equal:

$$\text{Passenger charge} = \frac{tax}{2}\ x\ (\text{Aircraft capacity})\ x\ (\text{Load factor}) \qquad \text{(f. 3.10)}$$

where:

- The value of the tax corresponds to the tax paid by each passenger buying a return flight ticket.
- The aircraft capacity equals 150 seats (see **table 3.12** for the assumptions related to the characteristics of the reference aircraft chosen for this study).
- The load factor is the one specified in section 3.5.2.2.

When comparing the situation of railways with the one of airways with regard to charges, it will be very important to bear in mind those hypotheses and assumptions. These assumptions result in a simplified and approximate value for the air charges.

3.5.1.2. Assumptions related to the aircraft characteristics

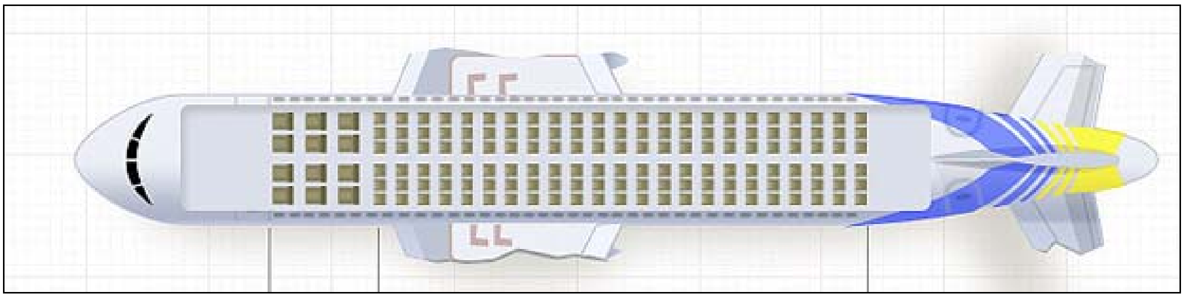
The aircraft selected for this study is the Airbus 320 (see **table 3.12** and **figure 3.8**), because of its widespread use in Europe. According to Airbus (2008), in January 2008 a total of 1.291 A230 aircrafts were in operation throughout Europe. Among the carriers offering services with an A320 in Europe there are legacy carriers such as, for instance, Air France, Alitalia, British Airways, Iberia and Lufthansa. There are low cost carriers as well. Clickair, Easyjet, Germanwings and Vueling are just some examples of low cost carriers using the A320 for their national and international flights in Europe.

TABLE 3.12 HYPOTHESES RELATED TO THE AIRCRAFT CHARACTERISTICS
Source: Sánchez-Borràs from Airbus (2008)

Aircraft characteristics		
Capacity	**Weight**	**Model selected**
150 seats(1)	MTOW(2) = 73,5	A320

Remarks:
(1) Number of seats in a typical two-class cabin layout (see **figure 3.8**).
(2) Maximum take-off weight.

FIGURE 3.8 AIRCRAFT CONSIDERED FOR THE CALCULATIONS. AIRBUS 320
Source: Donbassaero Airlines, 2008



3.5.2. Methodology and assumptions for the calculation of airways' revenues

Just like in railways, the calculation of airways' revenues requires knowing how much a passenger has to pay for its travel ticket, as well as knowing the capacity and average load factor of the aircraft:

$$Airways' \ revenues= (Capacity_{aircraft}) \ x \ (Load \ factor_{airways}) \ x \ (Ticket \ price_{airways}) \quad (f. 3.11)$$

3.5.2.1. Determination of the average ticket fare for airways

The assumptions made when calculating the airways average ticket fare were aimed at the obtaining of a value close to the real carriers' revenues, like it was aimed when determining the average ticket fare in railways.

The assumptions made are summarised in **table 3.13**. As done with railways' fares, the prices used correspond to ticket fares for trips departing around 8 a.m. from the origin point. However, air travel sees a widespread use of yield management[56], which translates into fuzzy ticket prices, variable even within a given route, carrier and time.

To gauge the extent of this variability, the evolution of ticket prices for a Wednesday flight from the origin point to the destination point were monitored during a week prior to flight time. Wednesday was the day chosen for this target flight, since its mid-work-week situation guarantees a high number of business trips. It was observed that buying the flight ticket with one week in advance can imply, in some cases, fares of approximately 60% the Y tariff. In any case, it depends on the politics of each carrier.

Since the journeys analysed start at 8 a.m. and, consequently, may correspond to business

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[56] Yield management is a management system consisting in applying different tariffs according to the demand type, taking into consideration its characteristics and behaviour, with the aim of maximising tariffs when the demand exceeds the offer, or maximising occupation when the offer exceeds the demand.

travels, it seemed reasonable to buy the ticket one week in advance. Therefore, despite the gauged variability, and further fluctuation caused by sharp differences between one-way and return tickets, in the end the price used for the current research was the cheapest return ticket available a week prior to the actual flight.

TABLA 3.13 ASSUMPTIONS ON AIRWAYS' REVENUES CALCULATION

Concept	Assumptions
Tariff	Tourist tariff (selling prices available)
Type of ticket	Return ticket: outward journey at 8 a.m. - for the national links of reference, comeback at 6 p.m., on the same day - for the rest of the links, next-day comeback
Price demand	Purchase of the ticket one week in advance (purchase one Wednesday to travel next Wednesday)
Search of prices	City O to city D and comeback

Therefore, in order to obtain the equivalent real revenues for airways, the price considered for air ticket fares was the one of the cheapest return ticket offered by a carrier offering a flight at (or near) 8 a.m. from the origin point to the destination point considered, divided by two. It implies that in some links, Legacy Carriers are taken into account, whilst in others it is Low Cost Carriers that are considered, depending on the air travel offer available in each link. No distinction was made between these two types of airlines, since according to SDG (2006), and as recently proved by Casas (2008), "the boundaries between low cost and classic airlines are breaking down" given the fact that on most routes, "there is little fundamental difference between the services offered by the different types of airline".

3.5.2.2. Determination of the load factor for airways

The load factor for airways has been determined on the basis of real data provided by the Association of European Airlines (AEA) for the period July 2005 – May 2006 (see **table 3.14**).

Taking into account that the assumption of the load factor must apply to both national and international links, the load factor for domestic European flights and geographical Europe has been considered. The calculated average value (67,3%) has been rounded to **70%**, which is the **load factor considered for this study**. **Figure 3.9** presents the results of the sensitivity analysis for a variation of (-5%, +5%) of the considered load factor (70%) on the value of the charges/revenues ratio, for the national links of reference presented in **table 3.2**.

TABLE 3.14 LOAD FACTOR FOR EUROPEAN AIRLINE TRAFFIC IN EUROPE
Source: Author's elaboration from AEA (2005a-e; 2006a-f)

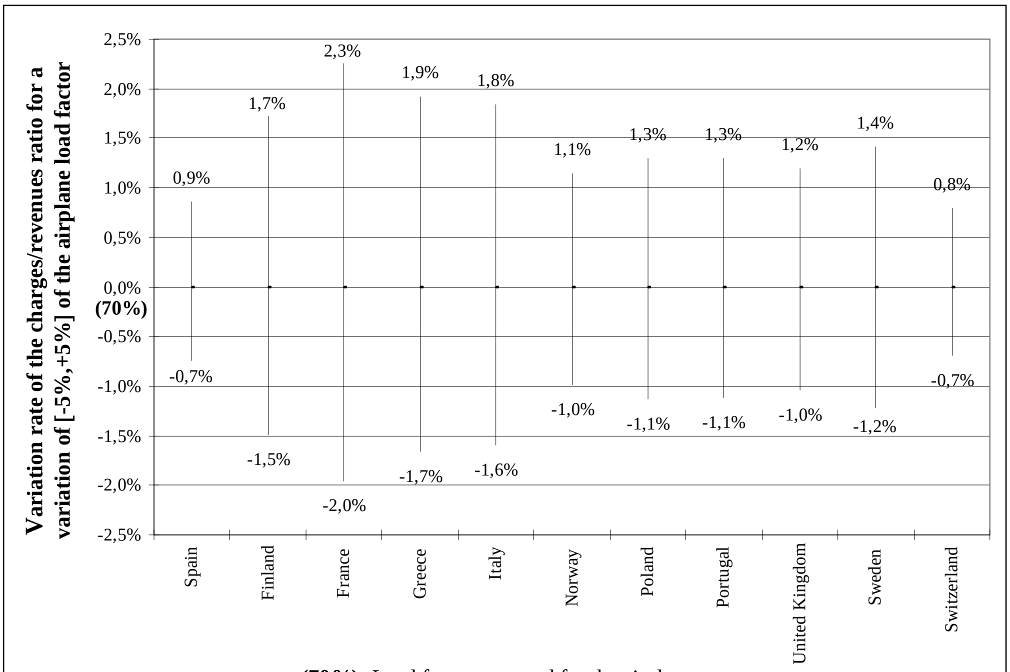
Month/year	Load factor[1] for: TOTAL Europe (Domestic + Geographical Europe)	Domestic	Geographical Europe[2]
July 2005	73,9%	70,8%	75,0%
August 2005	72,3%	68,9%	73,4%
September 2005	72,5%	68,4%	74,0%
October 2005	69,4%	67,3%	70,2%
November 2005	63,4%	64,3%	63,0%
December 2005	62,5%	64,6%	61,7%
January 2006	58,8%	59,5%	58,5%
February 2006	60,8%	62,0%	60,3%
March 2006	64,6%	64,5%	64,6%
April 2006	71,8%	69,8%	72,4%
May 2006	70,1%	69,6%	70,3%
Average value	67,3% ≅ **70%**	66,3%	67,6%

Remarks:

(1) AEA defines the load factor (PLP) as the percentage of seats on offer, filled by revenue passengers.

(2) AEA defines Geographical Europe as the territory including all cross border/international routes originating and terminating within Europe (including Turkey and Russia up to 55ºE), Azores, Canary Islands, Madeira and Cyprus.

FIGURE 3.9 SENSITIVITY ANALYSIS FOR THE LOAD FACTOR FOR AIRWAYS



(70%): Load factor assumed for the airplane

3.6. ASSUMPTIONS TO ANALYSE THE IMPACT OF A REDUCTION/ INCREASE IN RAIL INFRASTRUCTURE CHARGES ON HIGH SPEED TRAFFIC VOLUMES

The analysis of the impact that an increase in rail infrastructure charges can have on rail traffic volumes requires to establish a link between, on the one hand, infrastructure charges and, on the other hand, traffic demand.

As presented in f. 3.1, revenues from ticket sales are calculated as the fare times the capacity of the vehicle times the load factor. Therefore, they can also be expressed as:

$$Rev = F \times Q \tag{f. 3.12}$$

where:

- F corresponds to the ticket fare
- Q is the traffic expressed in passengers per train

Hence, the derivative of the revenues with respect to fare can be expressed as:

$$\frac{d(\mathrm{Re}\,v)}{dF} = \frac{d(F \times Q)}{dF} = \frac{dF}{dF} \cdot Q + \frac{dQ}{dF} \cdot F \tag{f. 3.13}$$

Combining f. 3.12 and f. 3.13, the relative change in revenues can be expressed as:

$$\frac{\Delta \mathrm{Re}\,v}{\mathrm{Re}\,v} = \frac{\Delta F \cdot Q + \Delta Q \cdot F}{F \cdot Q} = \frac{\Delta F}{F} + \frac{\Delta Q}{Q} \tag{f. 3.14}$$

On the other hand, ticket fares are linked to traffic volumes by means of the price elasticity of demand, which provides evidence on ability to pay without distortion of traffic levels and is defined to be “the percentage change in demand caused by a 1% change in price” (Glaister, 1981):

$$\varepsilon = \frac{\left(\Delta Q \middle/ Q\right) \cdot 100}{\left(\Delta F \middle/ F\right) \cdot 100} = \frac{\Delta Q}{\Delta F} \frac{F}{Q} \tag{f. 3.15}$$

where:

- ε is the price elasticity of demand
- Q is the traffic expressed in passengers
- F is the ticket fare (i.e. the price)

According to f. 3.15, the derivative of traffic with respect to fare can be expressed as:

$$\frac{\Delta Q}{Q} = \varepsilon \cdot \frac{\Delta F}{F} \qquad \text{(f. 3.16)}$$

Hence, substituting f. 3.16 in f. 3.14, the relative change in revenues can be expressed as:

$$\frac{\Delta \operatorname{Re} v}{\operatorname{Re} v} = \frac{\Delta F}{F} + \varepsilon \cdot \frac{\Delta F}{F} = \frac{\Delta F}{F} \cdot (1+\varepsilon) \qquad \text{(f. 3.17)}$$

If we assume that the profitability must remain unchanged, then the change in revenues must equal the change in infrastructure charges, that is to say:

$$\Delta \operatorname{Re} v = \Delta IC \quad \text{(Assumption: profitability unchanged)} \qquad \text{(f. 3.18)}$$

Thus, f. 3.17 can be expressed as:

$$\frac{\Delta IC}{\operatorname{Re} v} = \frac{\Delta F}{F} \cdot (1+\varepsilon) \qquad \text{(f. 3.19)}$$

From f. 3.19 it is possible to work out the **change in fare resulting from any change in infrastructure charge**:

$$\frac{\Delta F}{F} = \frac{1}{\operatorname{Re} v \cdot (1+\varepsilon)} \cdot \Delta IC \qquad \text{(f. 3.20)}$$

Combining f. 3.20 and f. 3.16, we can also work out the change in traffic resulting from any change in infrastructure charge:

$$\frac{\Delta Q}{Q} = \frac{\varepsilon}{1+\varepsilon} \cdot \frac{\Delta IC}{\operatorname{Re} v} \qquad \text{(f. 6.21)}$$

and introducing f. 3.12 in f. 3.21:

$$\Delta Q = \frac{\varepsilon}{1+\varepsilon} \cdot \frac{1}{F} \Delta IC \qquad \text{(f. 3.22)}$$

If we denote *a* the ratio between rail infrastructure charges (*IC*) and the revenues earned by RUs from ticket sales (*Rev*) for a given link:

$$\frac{IC}{\mathrm{Re}\,v} = a \qquad \text{(f. 3.23)}$$

and we substitute the revenues in f. 3.21 for the expression presented in f. 3.23, **the relative change in traffic can be expressed as a product of the relative change in infrastructure charge and two coefficients**:

$$\frac{\Delta Q}{Q} = \frac{\varepsilon}{1+\varepsilon} \cdot a \cdot \frac{\Delta IC}{IC} \qquad \text{(f. 3.24)}$$

In the present study, the assumptions on the calculation of revenues allow obtaining the average revenues and not the revenues according to the time of the day. Therefore, in infrastructure charging systems that do not distinguish between time periods, *a* is considered to be constant for each link analysed. In France, Spain, Italy and Belgium, where the current rail infrastructure charging systems distinguish between time periods, the calculated value of *a* is a bit higher than the average value, as a result of the assumptions made on rail charges calculation (see section 3.3.2.3).

F. 3.24 will be the tool used to analyse the impact that a reduction/increase in rail infrastructure charges can have on high speed traffic volumes. The values of *a* will be analysed in chapter 5 for the network modelled and correlated to the type of infrastructure.

3.7. ASSUMPTIONS TO ANALYSE THE POSSIBLE EFFECTS ON THE HIGH SPEED MARKET SHARE RESULTING FROM A REDUCTION/INCREASE IN RAIL INFRASTRUCTURE CHARGES

The assumptions to analyse the possible effects on the high speed market share resulting from a reduction/increase in rail infrastructure charges relate, on the one hand, to the link existing between a change in infrastructure charges and ticket fares and, on the other hand, to the link existing between a change in rail fares and the level of modal share.

3.7.1. Establishment of a link between infrastructure charges and rail ticket fares

F. 3.20 presented in the preceding section gives the change in fare resulting from any change in infrastructure charge, expressed as a product of the absolute change in infrastructure charges, the revenues earned by a railway operator from the ticket sales and the elasticity. Combining f. 3.20 with f. 3.23, the change in fare resulting from any change in infrastructure charge can be expressed as:

$$\frac{\Delta F}{F} = \frac{1}{(1+\varepsilon)} \cdot a \cdot \frac{\Delta IC}{IC} \qquad \text{(f. 3.25)}$$

3.7.2. Calibration of a market share model for European high speed links

As stated in section 3.2.3, the competition framework considered includes, exclusively, two modes of transport, namely high speed railways and airways. Therefore, the market share model to be calibrated should respond to a binary choice model.

SDG (2006) recently published a report on “Air and rail competition and complementarity” prepared for the European Commission DG TREN, in which a market share model for European high speed links is developed. In it, passengers’ choices between air[57] and rail transport are predicted by means of a logit model calibrated using data from European routes linked by high speed lines, with the ultimate objective of testing scenarios for the development of short haul transport over the next 10 years. The results of the market share model calibrated in this study are only presented graphically, which complicates its use for the purpose of the present research. However, the abovementioned report presents valuable data when trying to calibrate a market share model. Consequently, this data is the one used in the next sections when calibrating a market share model for European high speed links.

3.7.2.1. Description of the model

The model calibrated to quantify the change in rail-air market share resulting from a reduction (or increase) of rail infrastructure charges is a logit model.

The logit model is a discrete choice model based on the aleatory utility theory, the four main postulates of which are presented below (Domenich et al 1975):

- Individuals pertaining to a given homogenous population, *Q*, act in a rational way and have perfect information, i.e. they always choose the option that maximises their net personal utility subject to legal, social, physical and/or budgetary restrictions.

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[57] The logit model at hand does not separately identify low cost and classic airlines because, as seen in section 3.5.2, there is little fundamental difference between the services offered by different types of airline.

- There is a series of available alternatives A and a series of X passengers' and alternatives attributes vectors. An individual q is assigned a series of attributes $x \in X$ and, generally, it will choose amongst the options available $A(q) \in A$. In principle, it is assumed that the restrictions to which the individual q is subjected have already been taken into consideration and, therefore, they do not affect the choice amongst the different alternatives.

- Each option $A_j(q) \in A$ has an associated net utility for an individual q. This utility (U'_{jq}) is represented by a measurable (U_{jq}) part, which is a function of the average attributes x, and an aleatory (ξ_{jq}) part, which reflects the particular tastes of each individual as well as any error in the measurement or observation by the researcher.

- The individual q chooses the alternative that gives him the maximal utility, i.e. the individual chooses A_j if and only if $U'_{qj} \geq U'_{ij}$, $\forall A \in A(q)$.

Therefore, choices are made on the basis of the perceived utility (instead of the measured utility), which is aleatory and unknown and can be expressed as follows:

$$U'_i(\theta_i,A)= U_i(\theta_i,A) + \xi_i(\theta_i,A) \qquad \text{with} \qquad i=1, ..., m \tag{f. 3.26}$$

where:

- i refers to the mode of transport
- θ is the parameters vector for mode i
- A is the vector of the traveller's characteristics

For the logit model, it is assumed that the aleatory factor ξ_i has a Gumbel distribution. Therefore, the probability of choosing the transport mode "*HS*" can be expressed as follows:

$$P_{ij}^{HS} = \frac{e^{U_{ij}^{HS}}}{e^{U_{ij}^{HS}} + e^{U_{ij}^{Air}}} \tag{f. 3.27}$$

where:

- U_{ij}^{HS} is the measurable utility of high speed railways
- U_{ij}^{Air} is the measurable utility of airways

Consequently, the logit model allows representing systematic taste variation, that is, taste variation that relates to observed characteristics (e.g. schedule related factors, fares).

In addition, the logit probability presents the property of having an S-shaped relation to representative utility. This implies, on the one hand, that if the model projects a rail share of 20% for a relative utility of +n, it will project a rail share of 80% for a relative utility of –n; and on the other hand, that the point at which the increase in representative utility has the greatest effect on the probability of it being chosen is when the probability is close to 0,5, meaning a 50-50 chance of the alternative being chosen.

3.7.2.2. Definition of the utility function

By definition, the measurable utility function allows calculating the true cost of travel faced by the average passenger by a particular mode on a particular route. It can be expressed as:

$$U_{ij}^{k} = \alpha \cdot V_{ij}^{k} \qquad \text{(f. 3.28)}$$

where α is a scale factor applied to the measured utility V_{ij}.

In its simplest expression, the measured utility V*ij* corresponds to a weighted average of schedule related factors (converted into a monetary cost using value of time assumptions) and fares, which are the factors accounting for most of the variation in demand between routes. However, an accurate estimation of the utility value requires taking into account other aspects that also play a role in the prediction of the market share. Those are access costs and quality factor scores. Therefore, the utility function for a link *ij* and a mode of transport *k* can be expressed as follows:

$$V_{ij}^{k} = GJC \cdot \lambda + Scores \qquad \text{(f. 3.29)}$$

or

$$V_{ij}^{k} = \left[GJT + (Av\_fare)\cdot \gamma_1 + (Access\_\cos t)\cdot \gamma_2\right]\cdot \lambda + Scores \qquad \text{(f. 3.30)}$$

where:

- *GJT* is the generalised journey time, which corresponds to the monetarisation of the schedule related factors.
- *AV_fare* is the average fare of the travel ticket.
- *Access_cost* corresponds to the cost of journeys to/from the terminals.
- *GJC* is the generalised journey cost, which corresponds to the weighted sum of the generalised journey time, the average fare and the access cost.
- *Scores* corresponds to the quality factor scores.

- γ_1 and γ_2 are coefficients weighting the value of the average fare and the access cost.
- λ is a coefficient weighting the generalised journey time, average fares and access costs with regard to the weight of the quality factor scores.

With regard to the schedule related factors, they include, according to SDG (2006), journey time, check-in time, time required to leave a rail station or airport, and frequency. The conversion of these schedule related factors into a monetary cost using value of time assumptions is known as generalised journey time (GJT), and can be expressed as follows:

$$GJT = \left[IV_t \cdot \theta_1 + \left(\frac{24hours}{Freq\_tr\_day} \right)^{\theta_2 \cdot (MFP).} + ChIn_t \cdot \theta_3 + A_t \cdot \theta_4 \right] \cdot VoT \qquad \text{(f. 3.31)}$$

where:

- IV_t corresponds to the “in-vehicle time”, that is, the journey time.
- *Freq_tr_day* is the frequency expressed as the number of trains (or flights) per day.
- *MFP* is the minimum frequency penalty, expressed in minutes. It takes into account that low service frequency makes a mode relatively unattractive even if the journey time is faster, and vice versa, by translating differences in frequency into differences in journey time.
- $ChIn_t$ corresponds to the check-in time plus the terminal exit time (i.e. plus a time allowance to exit the airport).
- A_t is the access time, defined as the average time required to access the terminals.
- θ_1, θ_2, θ_3 and θ_4 are factors weighting the different times of each stage of a travel.
- *VoT* is the value of time and corresponds to the monetary value attributed to an hour.

Concerning the quality factor scores, they refer to factors such as reliability, accessibility and service quality. Their quantification is sometimes complicated either because sometimes there is no data available on the subject, or because the structure of this data varies between routes/operators.

3.7.2.3. Case studies data used to characterise the utility function

The model will be calibrated on the basis of seven different links where high speed railways compete with airways and for which SDG (2006) provides data on the components defining the utility of high speed railways and airways, as well as for which data on their mode split was available.

Tables 3.15, **3.16** and **3.17** present the characterisation, according to SDG (2006), of the average fare and access cost (**table 3.15**), the schedule related factors (**table 3.16**), and the quality factor scores (**table 3.17**). This data was obtained in the case studies.

The average fares presented in **table 3.15** correspond to average one-way ticket prices for each mode on each route. The values were estimated on the basis of a large sample of fares collected from the operators, which was subsequently weighted by the share of frequencies provided by each operator. With regard to the access cost (cost of journeys to/from the terminals) and access time, their values result from an estimation based on material collected for the case studies[58].

TABLE 3.15 AVERAGE FARE AND AVERAGE ACCESS COST
Source: Own from SDG (2006) data

	Average fare (€)		Access cost (€)	
Route	**Rail**	**Air**	**Rail**	**Air**
Frankfurt - Köln	42	72	5	10
London - Edinburgh	66	88	10	20
London - Paris	90	96	10	35
Madrid - Barcelona	55	97	5	10
Madrid - Sevilla	58	100	5	10
Milano - Roma	46	104	10	10
Paris - Marseille	63	108	10	15

The minimum frequency penalties presented in **table 3.16** are not directly proportional to the time gap between services. SDG (2006) has defined them by using an inverse power rule[59]. This means that the impact on market share of an improvement from a frequency of one train every 60 minutes to one every 30 is greater than the impact of an improvement from once every 120 minutes to once every 90. As a result of that, an increase in frequency of a service from every 2 hours to every 1 hour has the same impact on market share as an improvement in journey time of 20-25 minutes. The minimal value accepted for a frequency penalty is 15 minutes, since where frequency is very high, it is usually divided between several operators and it can be assumed that passengers' perceptions of frequency are based primarily on the one offered by the operator with which they have a ticket[60].

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[58] As a default, SDG (2006) proposes to use a rail access time of 30 minutes and an airport access time of 45 minutes, with higher or lower values on particular routes reflecting individual characteristics.
[59] This is in line with formulae used for frequency penalties in other transport models.
[60] In the railway field, this only applies to countries where there is competition in the market.

TABLE 3.16 SCHEDULE RELATED FACTORS AND ACCESS TIME
Source: Own from SDG (2006) data

Route	In-vehicle time (min)		Trains/ flights per day		Min freq. Penalty (min)		Check-in time (min)		Access time (min)		VOT[(*)] (€/hour)
	R	A	R	A	R	A	R	A	R	A	
Frankfurt - Köln	70	45	32	4	20	108	0	45	30	45	33
London - Edinburgh	270	85	19	79	29	15	0	45	40	45	33
London - Paris	160	75	15	54	35	15	30	75	30	75	24,16
Madrid - Barcelona	290	70	7	64	59	15	5	30	30	30	33
Madrid - Sevilla	150	70	22	7	26	59	5	45	30	45	33
Milano - Roma	270	75	20	36	28	18	0	45	30	30	33
Paris - Marseille	190	80	24	26	25	23	0	50	30	45	33

Remarks: R stands for railways and A for airways.

(*) On the London-Paris route, car does not represent a realistic alternative due to the time and cost involved in crossing the Channel, and therefore SDG (2006) assumes that 67% of passengers are travelling for leisure purposes. In the other cases, SDG (2006) assumes that 50% of passengers are travelling on business. The values used by this source are 59 €/hour for business passengers and 7 €/hour for leisure passengers, reflecting typical values used in other appraisals.

With regard to the quality factor scores, SDG (2006) defines four different quality factors:

$$Scores = (\mathrm{Re}\,liability) + (Airport\_links) + (\mathrm{Pr}\,icing\ \&\ Ticketing) + (Service\_quality) \qquad \text{(f. 3.32)}$$

where:

- *Reliability* reflects the proportion of trains/flights that actually run and arrive at their destination on time.

- *Airport links* reflects the existence of a direct link to other air services, and its degree of integration, for passengers that wish to make connections.

- *Pricing and ticketing* (or price variability) reflects the likelihood of passengers purchasing a ticket at a price that is lower than the average. This score is relevant in those cases where yield management systems are applied.

- *Service quality* reflects whether there is a premium class service and its quality (e.g. catering facilities available, quality of standard class premium and terminal facilities).

The values used in this study for these quality factor scores are presented in **table 3.17**.

The mode split currently registered in the high speed links used as case studies is the one presented in **table 3.18**.

TABLE 3.17 QUALITY FACTOR SCORES (10 IS BEST)
Source: SDG (2006)

Route	Reliability		Airport links		Price variability		Service quality		Scores	
	R	A	R	A	R	A	R	A	R	A
Frankfurt - Köln	9	8	6	10	7	9	6	5	**28**	**32**
London - Edinburgh	2	5	0	10	5	10	7	5	**14**	**30**
London - Paris	8	2	0	10	6	9	9	4	**23**	**25**
Madrid - Barcelona	8	6	0	10	0	6	8	5	**16**	**27**
Madrid - Sevilla	10	6	0	10	0	5	9	5	**19**	**26**
Milano - Roma	9	6	0	10	7	7	7	4	**23**	**27**
Paris - Marseille	6	5	2	10	5	5	7	3	**20**	**23**

Remarks: R stands for railways and A for airways.

TABLE 3.18 MODAL SPLIT REGISTERED IN THE LINKS ANALYSED
Source: Own from SDG (2006) data

Route	Rail market share
Frankfurt - Köln	97%
London - Edinburgh	18%
London - Paris	69%
Madrid - Barcelona	12%
Madrid - Sevilla	86%
Milano - Roma	38%
Paris - Marseille	67%

3.7.2.4. Calibration of the market share model

The calibration of the market share model consists in calibrating the scale factor α, as well as defining the value of time and the coefficients affecting the key inputs of the utility function, which are:

- γ_1, γ_2: coefficients weighting the average fare and access cost, respectively
- θ_1, θ_2, θ_3, θ_4: coefficients weighting the times of each stage of a journey

- λ: scale factor for the generalised journey cost

In **table 3.19** the weights applied by the author to the coefficients affecting the key inputs of the utility function are presented. As it can be seen, the weight attributed to the check-in time and to the access time is higher than the one attributed to the journey time. This is because it is generally assumed that the traveller's perception of time differs according to the travelling stage. On the other hand, the value attributed to the frequency power (θ_2) is the one that seems to best fit the utility function. With regard to the average fare and the average cost, a factor equal to 1 was defined. Finally, since the generalised journey cost reflects the disutility of the travel (the utility drops with the cost[61]), the scale factor for the generalised journey cost (λ) was given a negative value (consequently, the scale factor α will be positive). The quality factor scores, which quantify positive aspects of the journey (e.g. reliability, accessibility, etc.), will reduce the disutility implied by the generalised journey cost.

TABLE 3.19 CALIBRATION OF THE UTILITY FUNCTION

γ_1	γ_2	θ_1	θ_2	θ_3	θ_4	λ
1	1	1	7,5	1,5	1,25	-1

With regard to the value of time, there is no common value of time used for use in European appraisals. For the present study, the value defined by SDG (2006) is the one that will be used. This corresponds to a VoT of 59 €/hour for business passengers and 7 €/hour for leisure passengers. Assuming that on high speed links there is a high proportion of business travelers, SDG (2006) assumes that on most of high speed routes 50% of passengers are travelling on business[62], while on high speed routes crossing the Channel Tunnel it is assumed that 67% of passengers are travelling for leisure purposes[63]. These assumptions give an average VoT of 33 €/hour (and 24,16 €/hour for links crossing the Channel Tunnel). This value is consistent with the ones given by other authors. For instance, Hammadou et al (2002) propose an average VoT of 37 €/hour for French air traffic, while Boiteux (2001) proposes a VoT of 32,3 €/hour for first class railways for

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[61] Logit models assume that travel always has a negative utility, mostly in terms of time and cost, i.e. passengers would rather not make the journey, but the positive benefit from doing so (for example, attending a business meeting) offsets the disutility of the journey (SDG, 2006).

[62] According to SDG (2006), this is relatively high compared to other air and rail routes but reflects the fact that many of these routes are quite short and therefore many leisure passengers, particularly those travelling with families or in groups, would travel by car. The same source adds that where figures for the proportion of passengers travelling on business are available, they are consistent with this assumption.

[63] This exception is justified by the fact that car does not represent a realistic alternative due to the time and cost involved in crossing the Channel Tunnel (SDG, 2006).

distances greater than 400 kilometers.

With these values of time and the coefficients affecting the key inputs of the utility function, and the current market shares, the scale factor α can be easily calibrated by applying a linear regression to f. 3.27 as follows:

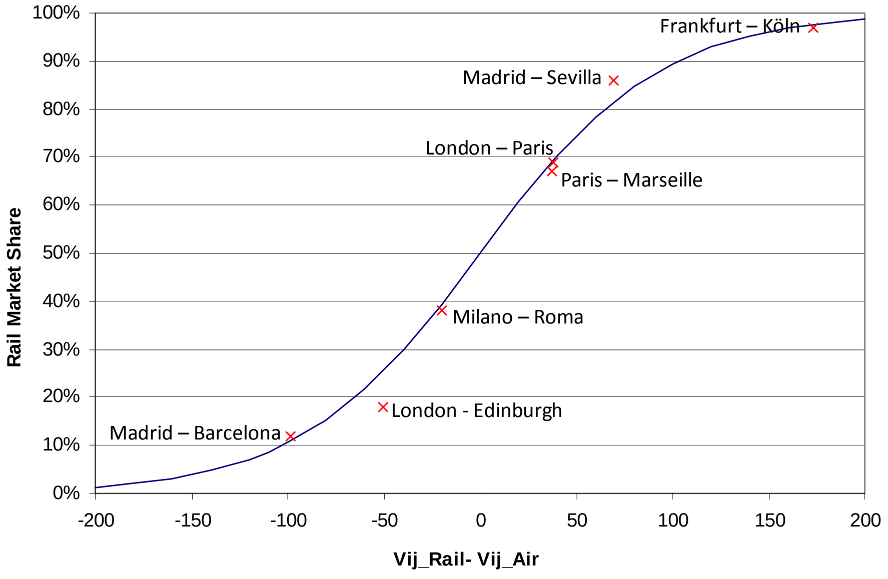
$$\ln\left(\frac{1}{p_{ij}^{HS}}-1\right)=\alpha\cdot\left(V_{ij}^{Air}-V_{ij}^{HS}\right) \qquad \text{(f. 3.33}^{64}\text{)}$$

In f. 3.33:

- $\ln\left(\frac{1}{p_{ij}^{HS}}-1\right)$ is the dependent variable (y)
- $\left(V_{ij}^{Air}-V_{ij}^{HS}\right)$ is the explanatory variable (x)
- α is the scale factor to be calibrated

FIGURE 3.10 MARKET SHARE MODEL: MARKET SHARE OF AIR/RAIL SERVICES AGAINST THE RELATIVE UTILITY OF TRAVEL BY EACH MODE

$$p_{ij}^{HS}=\frac{1}{1+e^{\alpha\left(V_{ij}^{Air}-V_{ij}^{HS}\right)}} \quad \text{with} \left\{\begin{array}{l}\alpha = 0{,}0214\\ R^2 = \ 0{,}9838\\ \textit{95\% confidential interval for the scale factor } \alpha\text{: [CI] = [0,018;0,025]}\end{array}\right.$$



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[64] Since 0 < $p_{ij}^{HS} < 1 \Rightarrow \left(\frac{1}{p_{ij}^{HS}}-1\right) \geq 0$; Hence ln can be applied to f. 3.27.

The results of the calibration are presented in **figure 3.10**. It reflects that with the aforementioned assumptions made the model calibrates well.

3.7.2.5. Validation of the market share model for European high speed links

The validation of the model was done with data available for five of the 100 links presented in **tables 3.3** and **3.4** and for which the mode split was known, namely Madrid-Seville, Paris-Strasbourg, Paris-Lyons, Paris-Marseilles and Paris-Bordeaux. The data used is presented in **tables 3.20**, **3.21**, **3.22** and **3.23**.

In this case, the average fares for rail and air transport were calculated as specified in sections 3.4 and 3.5. With regard to access costs, they depend on the origin station/airport. Therefore, the values adopted for the links with its origin in Paris are the same as the ones proposed in **table 3.15** for the journey starting in Paris. The equivalent assumption applies to the Madrid-Seville link.

TABLE 3.20 AVERAGE FARE AND AVERAGE ACCESS COST. LINKS FOR MODEL VALIDATION

Route	Average fare (€)		Access cost (€)	
	Rail	Air	Rail	Air
Paris - Lyon	44,03	123,34	10	15
Madrid - Sevilla	52,35	165,9	5	10
Paris - Strasbourg	34,65	138,42	10	15
Paris - Bordeaux	47,78	186,66	10	15
Paris - Marseille	56,4	193,44	10	15

TABLE 3.21 SCHEDULE RELATED FACTORS AND ACCESS TIME. LINKS FOR MODEL VALIDATION

Route	In-vehicle time (min)		Trains/ flights per day		Min freq. Penalty (min)		Check-in time (min)		Access time (min)	
	R	A	R	A	R	A	R	A	R	A
Paris - Lyon	115	65	33	27	20	24	0	50	30	45
Madrid - Sevilla	140	60	22	13	26	38	5	45	30	45
Paris - Strasbourg	284	60	17	19	38	29	0	50	30	45
Paris - Bordeaux	191	70	19	43	29	17	0	50	30	45
Paris - Marseille	183	65	24	45	25	18	0	50	30	45

Remarks: R stands for railways and A for airways.

The journey time (in-vehicle time) was obtained from the tickets “bought”, and the frequency calculated from Cook (2005) for railways and the airports’ websites for airways. With regard to the minimum frequency penalty, its quantification was based on the assumptions presented in section 3.7.2.3. Concerning the check-in and the access times, it was assumed that the values for the French and the Spanish links given in **table 3.16** are valid in other French and Spanish national links. The same assumption was made when defining the quality factor scores of the French links used for the model validation (see **table 3.22**).

Finally, the (real) rail market share for the links used for the model validation is the one presented in **table 3.23**.

TABLE 3.22 QUALITY FACTOR SCORES (10 IS BEST). LINKS FOR MODEL VALIDATION

Route	Reliability		Airport links		Price variability		Service quality		Scores	
	R	A	R	A	R	A	R	A	R	A
Paris - Lyon	6	5	2	10	5	5	7	3	**20**	**23**
Madrid - Sevilla	10	6	0	10	0	5	9	5	**19**	**26**
Paris - Strasbourg	6	5	2	10	5	5	7	3	**20**	**23**
Paris - Bordeaux	6	5	2	10	5	5	7	3	**20**	**23**
Paris - Marseille	6	5	2	10	5	5	7	3	**20**	**23**

Remarks: R stands for railways and A for airways.

TABLE 3.23 MODAL SPLIT REGISTERED IN THE HIGH SPEED LINKS ANALYSED. LINKS FOR MODEL VALIDATION
Source: Own from López-Pita et al (2007) and Sánchez-Borràs et al (2008a) data

Route	Rail market share
Paris - Lyon	92%
Madrid - Sevilla	92%
Paris - Strasbourg	60%
Paris - Bordeaux	68%
Paris - Marseille	69%

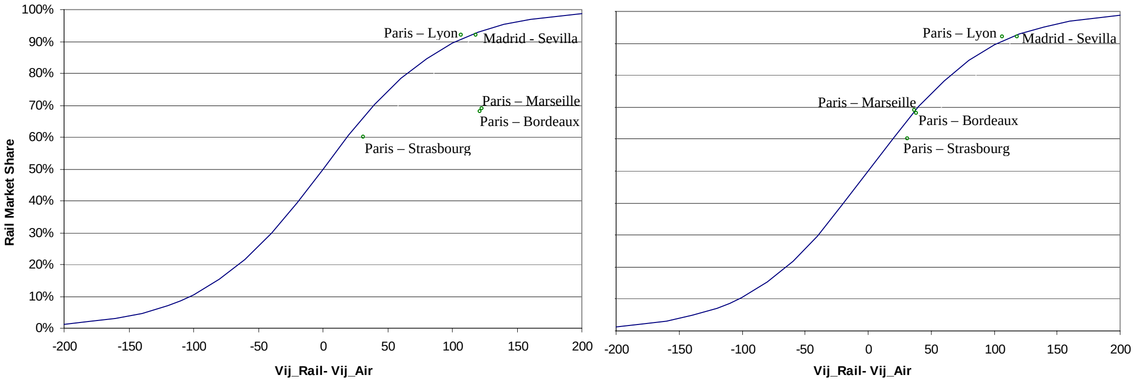
Figure 3.11 shows the results of the model validation obtained from the data presented in **tables 3.20** to **3.23**. It can be seen that the model is only properly validated after applying

a factor of 1,8 to air ticket fares for those French links served by services running on new high speed lines and offering journey times of around 3 hours (see **figure 3.11b**). If, on the contrary, the assumptions on the calculation of air ticket fares presented in section 3.5.2 are applied to these links, the results do not come close to the actual average fare; indeed, the value obtained for the Paris-Marseilles link with the assumptions presented in section 3.5.2 is for instance almost twice as high as the average value given by SDG (2006) for the same link. This could be explained by the fact that in such links, the application of yield management may lead to especially high air ticket fares at the morning peak[65] compared to the fares for other time periods.

TABLE 3.11 MARKET SHARE MODEL VALIDATION

a) **Results of the model validation with the data presented in tables 3.20 to 3.23**

b) **Results of the model validation applying an adjustment to air fares (factor of 1,8)** for French links served by services running on new high speed lines and offering journey times of around 3 hours, in order to bring air fares nearer to the average ticket fare.



Route	Market share	
	Real	Model
Paris - Lyon	92%	90,7%
Madrid - Sevilla	92% (1)	92,6%
Paris - Strasbourg	60%	66,1%
Paris - Bordeaux	68%	93,1%
Paris - Marseille	69%	93,3%

(1) Value obtained from López-Pita et al (2007). It differs from the one published by SDG (2006).

Route	Market share	
	Real	Model
Paris - Lyon	92%	90,7%
Madrid - Sevilla	92% (1)	92,6%
Paris - Strasbourg	60%	66,1%
Paris - Bordeaux	68%	69,4%
Paris - Marseille	69%	69,9%

(1) Value obtained from López-Pita et al (2007). It differs from the one published by SDG (2006).

Therefore, the validated model, which is the one that will be used in chapter 6 to quantify the change in market share resulting from a reduction (or increase) in rail infrastructure charges, takes the following expression:

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[65] As seen in sections 3.3 and 3.5, the fare tickets calculated for this study are the ones applicable to journeys starting at 8 a.m.

$$p_{ij}^{HS} = \frac{1}{1+e^{0,0214\cdot\left(V_{ij}^{Air}+V_{ij}^{HS}\right)}} \qquad \text{(f. 3.34)}$$

with:

$$V_{ij}^{k} = \left(-VoT\right)\cdot\left[IV_t + \left(\frac{24hours}{Freq\_tr\_day}\right)^{7,5\cdot MFP} + 1,5\cdot ChIn_t + 1,25\cdot A_t\right] -$$

$$- Av.fare - Access.\cos t + Scores \qquad \text{(f. 3.35)}$$

being VoT equal to 33 €/hour, except for the links crossing the Channel Tunnel, for which VoT equals 24,16 €/hour.

3.8. OUTPUTS FROM THE CALCULATIONS OF INFRASTRUCTURE CHARGES AND REVENUES

The outputs from the calculations of infrastructure charges and revenues for the links composing the network modelled in section 3.2.2 are presented in annex A6. Annex A7 summarises the segmentation and the assumptions needed in order to calculate the rail infrastructure charges for a selection of the links presented in **tables 3.2** and **3.3**[66].

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[66] The segmentation is presented only for a selection of links because of the large amount of pages that would be needed to summarise it for all the links analysed. Nevertheless, the segmentation and assumtions needed in order to calculate the rail infrastructure charges for the rest of the links are available on request.

CHAPTER 4

ANALYSIS OF THE STRUCTURE AND VALUE OF RAIL CHARGES FOR THE USE OF RAIL INFRASTRUCTURE IN THE EUROPEAN HIGH SPEED NETWORK

4.1. INTRODUCTION

As stated in chapter 3, this chapter focuses on the analysis of the rail infrastructure pricing systems implemented in the European railway networks, with the aim of analysing and quantifying the mark ups above marginal cost that are being charged to high speed services running on the European high speed lines, as well as coming to some conclusions on the criteria for applying mark ups in the pricing systems implemented on the European high speed railway network[67].

4.2. CHARACTERISATION OF THE PRICING SYSTEMS IN COUNTRIES WITH HIGH SPEED LINES IN OPERATION

In chapter 2 a brief introduction has been presented on the current situation of European charges for the use of rail infrastructure. This section thoroughly analyses the specificities of the rail infrastructure charging systems of the countries with high speed lines in operation, paying special attention to the charging specificities in high speed lines and the application of mark ups.

Annex A1 (**figure A1.7** and **table A1.2**) shows that new high speed lines have been built in France, Spain, Germany, Italy, Belgium, the United Kingdom, Denmark and Sweden.

The new high speed lines built Denmark and Sweden present the specificity of being bridges. On the other hand, in the United Kingdom passenger transport is mostly carried out by franchised passenger train operators. Because of these peculiarities, the charging systems of these three countries will be treated separately in annex A8. In section 4.2, the characterisation of the pricing systems focuses on France, Spain, Germany, Italy and

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[67] Being the European high speed railway network the one modelled and defined in chapter 3.

Belgium, which all of them have more than 100 km of new high speed lines within their territory (see annex A1, table A1.2).

4.2.1. French rail infrastructure charging system

The current French infrastructure manager and owner of the French railway network, *Réseau Ferré de France* (RFF), was created in 1997 by Law Nr 97-135 as a state-owned company. Since then, RFF bills SNCF (the national French operator) as a railway undertaking. From 1997 to 2001, RFF billed SNCF lump sums as charges but since 2002, a dedicated charging information system is applied (Remond, 2004).

The current legal framework for rail infrastructure charges is defined in decrees ("arrêtés"), approved by the Ministry of Transport on proposal of RFF. They contain the structure and the amount of charges for the use of rail infrastructure. Its content is published in the annual Network Statements, the preparation and publication of which is under RFF's responsibility.

Infrastructure charges for the use of the French railway network are based on short-run marginal costs[68]. Hence, charges cover the marginal costs of using the existing infrastructure, including scarcity/congestion costs but excluding external accident, air pollution and noise costs, which are neither covered by charges nor any other means. Infrastructure charges also partly cover traffic management, maintenance, renewals and investment costs, by means of mark ups to the marginal cost. This stems from the contents of law 91-135, which does not allow RFF to accept any development project if no balance between new cost and new charges is made, either by government or local authorities subsidies or by means of mark ups on infrastructure charges.

With this MC+ charging system, in 2004 RFF covered 63% of its total infrastructure costs (including loans and grants), as well as 90% of its infrastructure maintenance costs (CEMT, 2005); the remaining percentage being paid by the central government, except for renewals and investment costs, which are sometimes covered by regional governments. The total infrastructure expenditure recovery is currently expected to be higher than the one registered in 2004: according to Remond (2004), RFF was allowed to increase its 2004 and 2005 prices in order to reach the "small balance" between charges incomes and maintenance-operation costs as from 2008. The charges calculated for 2006 in two high speed links, Paris-Lyons and Paris-Marseilles, show that, indeed, infrastructure charges

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[68] However, according to the French Network Statement, infrastructure charges would be determined according to financial considerations. This would mean that a detailed calculation of infrastructure marginal costs would not be carried out.

did increase in the 2004-2006 period: running from Paris to Lyons cost 11,09 €/train-km in 2004 (Remond, 2004) versus 14,6 €/train-km in 2006 (Sánchez-Borràs from data from RFF's Network Statement 2006); for the same period, in the Paris-Marseilles link charges amounted 8,55 €/train-km in 2004 and 10,3 €/train-km in 2006 (same sources as for Paris-Lyons).

In annex A3 the structure and the tariffs of the French pricing system have been summarised, according to the data published in RFF's Network Statement for 2006. Its structure follows the one outlined in Directive 2001/14/EC (see **figure 1.11**). With regard to the minimum access package, charges are divided into two different groups according to the characteristics they reflect:

- Charges reflecting infrastructure characteristics (access charge and reservation charge, both for train-paths and stations)

- Charges reflecting traffic characteristics (running charge)

The access charge is a fixed charge, whilst the other ones are variable. Therefore, the charging system corresponds to a two-part tariff structure.

In France, the marginal costs for using the infrastructure are approximately reflected in the running charge and the charge for electric traction facilities[69]. The running charge[70] is supposed to reflect the cost of running different types of trains on the network (national and regional passenger trains and freight trains). However, according to Gaudry and Quinet's (2003) findings, regional passenger trains should pay higher running charges than national passenger trains and freight trains, since the relative marginal costs of the former have been found to be higher than the latter (see section 1.4.2.1). This could be interpreted as charges meant to consider wear and tear costs actually being rather set to reflect the operator's ability to pay distinguishing by category of passenger and freight train. Perhaps it also allows for the fact that higher infrastructure quality is often linked

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[69] The charge for electric traction facilities only covers the cost of the substations and the overhead contact lines, i.e. it does not cover all the costs of maintenance of the transmission and distribution network belonging to RFF (CENIT et al, 2007a). Its value depends on the type of train, being national high speed trains the ones having to pay higher amounts for this concept (0,442 €/train-electric km, compared to 4,33 €/train-electric km for regional passenger trains Île de France, 0,317 €/train-electric km for national passenger trains other than high speed trains, 0,36 €/train-electric km for freight trains and 0,219 €/train-electric km for other regional passenger trains). The power transmission (charge for additional services) is charged separately and adjusted periodically taking into consideration the evolution of electricity public charging.

[70] The running charge is expressed in unit price per train-kilometre and currently it does not distinguish per type of infrastructure, even if the structure of the network statement makes think that it will do so in the future. Therefore, the structure of the network statement makes think that in the future, running charges will consider scarcity, like access and reservation charges currently do.

with high average maintenance costs due to more restrictive maintenance intervention thresholds, even if the marginal cost is low (this aspect will be further developed in section 4.4).

The mark ups implemented in the French charging system have been introduced in the fixed component (access charge) and the reservation charge (both for train paths and for stopping at a station), which are clearly subject to substantial mark ups, differentiated by broad category of passenger train, location and time of day.

The fixed component (access charge) is given in €/train-km and reflects the different quality levels of the sections composing the railway network as well as the amount of traffic borne (high, medium and low) and, in some cases, the maximum speed allowed on those. These quality levels are defined by classifying the sections composing the network into four different categories: suburban lines, main intercity lines, high speed lines and other lines.

With regard to high speed lines, they are classified into five different subcategories[71], namely:

- N1: High speed lines with high traffic (*TGV Sud Est*, *TGV Atlantique* –from Paris to Courtalain– and *TGV Nord Europe* –from Paris to Lille–).

- N2: High speed lines with medium traffic (*TGV Rhône Alpes*, *TGV Nord* –from Lille to Belgian border, *TGV Jonction Atlantique*, *TGV Atlantique* –from Courtalain to Le Mans and St Pierre bifurcation– and *TGV Nord Europe* from Lille to Hazebruck–).

- N2*: Mediterranean high speed line with medium traffic (*TGV Méditerranée* –from Valence to Roquemoure–).

- N3: High speed lines with low traffic (*TGV Atlantique* –from St Pierre bifurcation to Monts, *TGV Jonction* and *TGV Nord-Europe* –from Hazebruck to Calais).

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[71] According to Remond (2004), the length in kilometres for each subcategory is as follows: 287 km for subcategory A (suburban lines with high traffic); 985 km for subcategory B (suburban lines with medium traffic); 7.209 for subcategories C (main intercity lines with high traffic) and C* (main intercity lines with high traffic and maximal speeds of 220 km/h); 5.840 for subcategories D (main intercity lines with medium traffic) and D* (main intercity lines with medium traffic and maximal speeds of 220 km/h); 12.738 km for subcategory E; 718 for subcategory N1; 457 for subcategories N2 and N2*; and 321 km for subcategories N3 and N3*.

- N3*: Mediterranean high speed line with low traffic (*TGV Méditerranée* –from Roquemoure to Marseilles–).

The access charge is the same for all high speed lines subcategories (0,946 €/km) and its value is about 60 times higher than the one charged to other types of lines, for which a charge of 0,015 €/train-km (for suburban lines –A, B– and main intercity lines with high traffic –C, C*–) or 0,000 €/train-km (for main intercity lines with medium traffic or other lines) is due.

Reservation charges are divided into a train-path reservation charge and a reservation charge for stopping at a station. Both types differentiate tariffs according to the infrastructure categorisation presented above, as well as to the time of day, considering three different options (off-peak, normal and peak hour), which ensure that the operators that value more the traffic in peak hours pay more for reserving the capacity.

Concerning the train-path reservation charge, it is expressed in terms of euros per train-kilometre reserved. For high speed lines, three different tariffs are defined: a more expensive one for subcategory N1, a cheaper one for subcategories N2 and N2* and an even cheaper one for subcategories N3 and N3*. With regard to the tariffs applied to the other line categories, in peak and off-peak hours train-path reservation charges for high speed lines are more expensive than for the rest of lines, with the exception of suburban lines with high traffic (subcategory A), which are more expensive at peak hours. The same applies to normal hours, with the particularity that in this case the charge for high speed lines with high traffic (subcategory N1) is the highest. According to Remond (2004), these differences are linked to the scarcity of capacity, according to the level of traffic registered on each line. CENIT et al (2007a) add that it could be considered that congestion is charged by reservation charges according to two different parameters: the time period and the situation of the line with regard to a big city (in view of the spatial distribution of the different subcategories). Therefore, the reservation charge can be considered as a proxy for scarcity costs related to the use of the infrastructure. In addition, the same source considers that mark ups related to high potential demand markets could be behind the definition of different subcategories for same infrastructure characteristics (e.g. high speed lines), which result in higher prices in sections close to main cities like Paris and Lyons.

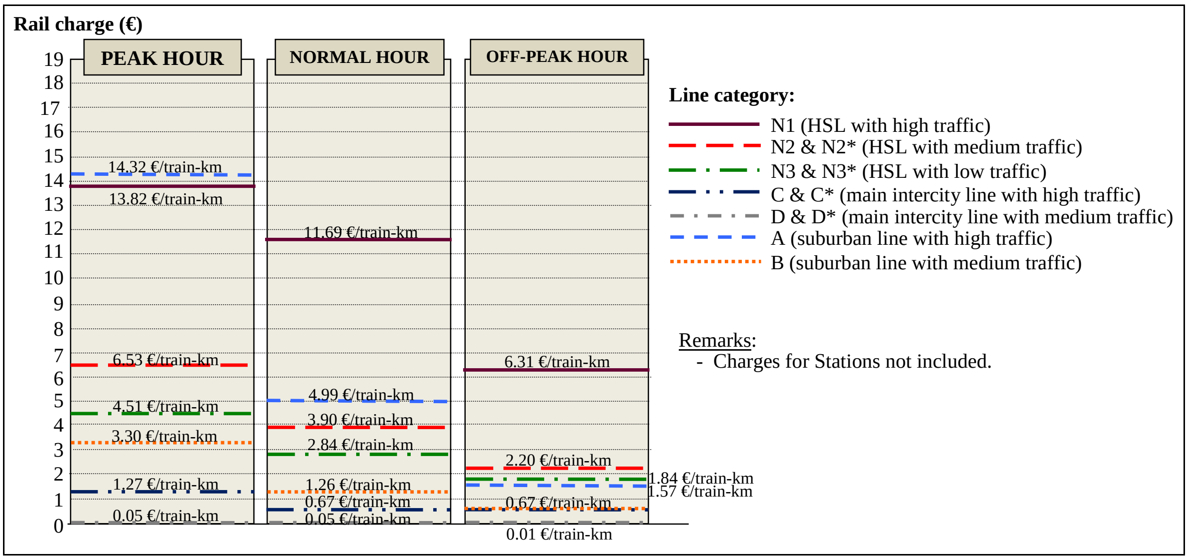
With regard to the reservation charge for stopping at a station, it is expressed in euros per stop reserved. This charge only has to be paid in runs taking place at normal and peak hours. In both cases, tariffs for high speed lines and suburban lines with high traffic (subcategories N1 and A) are equivalent (7,200 €/train and 24,350 €/train for normal and peak hours, respectively). For the rest of lines, the reservation fee amounts 5,500 €/train for runs taking place at normal hours and 21,200 €/train for those taking place at peak hours (with the only exception of category E, for which the charge is lower: 10,000 €/train). Like train-path reservation charges, reservation charges for stopping at a station reflect the scarcity of capacity of the infrastructure.

Reservation charges, which in 2005 amounted to more than 60% of total infrastructure fees, appear to be where most mark ups are applied. IMPRINTE-NET (2006) highlighted that mark ups above marginal cost for high speed lines with high traffic (N1) amount to many times marginal cost (see **table 4.1**). Calculations done by the author for the year 2006 for runs at peak periods, give charges of 14,6 and 10,3 €/train-km for the Paris-Lyons and the Paris-Marseilles links, respectively, values considerably higher than the optimal mark up defined in chapter 1 (section 1.4.2.3). According to Crozet (2006), the strong demand with low elasticity allows applying such high mark ups, which result from the application of a Ramsey-Boiteux pricing scheme. And according to RFF’s recent suggestions to French transport policy makers, charges could be further modulated so that unprofitable routes or services are funded through a levy on high speed rail undertakings turnover (Sauvant, 2008).

TABLE 4.1 INFRASTRUCTURE CHARGES AND MARGINAL COSTS OF THE FRENCH RAILWAY NETWORK IN 2005
Source: Crozet (2006) from SESP

		Millions trains-km	Maintenance costs	Renewal costs	Total Cost (M€)	Marginal Cost (M€)	2005 RFF charges (M€)
High speed lines	N1	53,4	72,3	91	163	110	655
	N2	12,5	26,1	24	51	27	61
	N3	3,4	12,4	8	20	8	12
	N2*	5,6	10,3	11	21	12	27
	N3*	3,4	9,5	7	16	8	12
	Tot.	**78,3**	**130,6**	**141**	**271**	**166**	**767**
Others	A	44,4	190	53	243	137	509
	B	59,8	231	71	303	172	264
	C	230,5	887	275	1.162	497	418
	C*	17,9	51	21	72	35	45
	D	78,2	499	219	718	281	123
	D*	2,6	8	7	15	8	7
	E	41,2	526	108	633	130	61
	Tot.	**474,6**	**2.392**	**754**	**3.145**	**1.260**	**1.427**
Total		**552,9**	**2.522**	**895**	**3.416**	**1.426**	**2.194**

FIGURE 4.1 LEVEL OF CHARGES FOR THE FRENCH RAILWAY NETWORK IN 2006
Source: Sánchez-Borràs et al (2009).



Remarks:
- Charges for Stations not included.

TABLE 4.2 WEIGHT OF THE FIXED AND VARIABLE CHARGES FOR FRENCH NATIONAL HIGH SPEED LINKS
Source: Sánchez-Borràs from data from RFF's Network Statement 2006 (RFF, 2004)

Link	Fixed charge		Variable charge	
	In €	% fixed/total	In €	% variable/total
Paris – Strasbourg	6,8 €	0,4 %	1.528,7	99,6 %
Paris – Bordeaux	207,9 €	6,1 %	3.209,6	93,9 %
Lyon – Marseille	321,2	12,1 %	2.325,4	87,9 %
Paris – Rennes	174,4	6,3 %	2.586,3	93,7 %
Paris – Marseille	695,0	9,0 %	6.991,5	91,0 %
Paris – Tours	202,7	7,7 %	2.414,7	92,3 %
Paris – Lyon	390,7	6,2 %	5.912,3	93,8 %
Paris – Lille	198,5	5,8 %	3.207,4	94,2 %

Remark: The low fixed charge in the Paris-Strasbourg link compared to the other links is due to the fact that in 2006 this link was a conventional line from beginning to end.

It must be noted that the ability to pay principle has been applied in France in a quite detailed way, since, for a given link, such as for instance Paris-Lyons, the segmentation of the infrastructure in different categories permits differentiation of charges according to different ability to pay levels along the link. Indeed, starting from Paris, the link is defined as being constituted by category A (suburban line with high traffic), N1 (high speed line with high traffic), N3 (high speed line with low traffic), C (main intercity line with high traffic) and finally A again at its arrival in Lyons.

Figure 4.1 summarises the unit level of charges for the French railway network, resulting from the charging system described. On the other hand, **table 4.2** shows that this structure of charges entails a two part tariff structure where the variable component of the charge has a very important weight (around 90% of the total charges) whereas fixed charges take a secondary role.

4.2.2. Spanish rail infrastructure charging system

The current Spanish infrastructure manager, *Administrador de Infraestructuras Ferroviarias* (Adif), was established in 2005 as the result of the integration of GIF (the former rail infrastructure manager, in charge of the construction and the operation of new high speed lines) with Renfe and the segregation of the Operation Services, which currently constitute Renfe-Operadora, the national Spanish rail operator.

The legal framework for rail infrastructure charges is defined by the Railway Sector Spanish Law 39/2003 of 17 November (*Ley del Sector Ferroviario*, LSF). In its Titles II and III, the LSF establishes that the settlement of charges or private prices for the provision of additional, supplementary and ancillary services corresponds to Adif. In addition, in its Titles V and VI, and articles 74 and 75, the LSF establishes a tariff for using railway lines to be applied for the allocation of the network capacity and the use of stations and other railway facilities. The amounts of these tariffs are currently set through two Ministerial Orders. On the one hand, ORDEN FOM/897/2005 regulates the preparation, contents and publishing of the Network Statement, whereas ORDEN FOM/898/2005 defines the level of infrastructure charges.

In accordance with Law 39/2003, the basic charging structure reflects the costs incurred by the infrastructure manager by introducing different parameters (time period, level of traffic, type of line and service, distance covered, type of contract, and type of homologation). Hence, infrastructure charges for the use of the Spanish railway network are based on marginal costs.

In annex A3 the structure and tariffs of the Spanish pricing system have been summarised, according to the data published in Adif’s 2006 Network Statement. Tariffs are divided into tariffs for the minimum access package and tariffs for track access to services facilities and supply of services. In addition, there is a safety fee for passenger transport and a fee for approval of railway staff training centres and rolling stock maintenance depots.

Tariffs for the minimum access package comprise an access tariff, a reserve capacity tariff, an operating tariff and a traffic tariff. The tariffs for track access to services facilities and supply of services include five different components: a tariff for stations use, a tariff for stabling and use of platforms at stations, a tariff for passing track gauge changers, a tariff for use of sidings and a tariff for provision of services requiring permission for use of public railway property. As in the French case, the access tariff is a fixed charge, whilst the other ones are variable. Therefore, the charging system corresponds to a two-part tariff structure.

In Spain, in line with the French charging system, the marginal costs for using the infrastructure are approximately reflected by the running charge (operating tariff, established according to the train-kilometres actually used and regulating the actual use of reserved capacity), which is set according to the variable maintenance, operation and rail infrastructure management costs. However, this charge is again differentiated, since services running on high speed lines see a tariff varying according to the type of line and the service offered (top speed higher or lower than 260 kilometres per hour), which can be interpreted as a mark up according to the ability to pay of the market for faster trains, as well as according to construction costs.

With regard to the other additive charges, the access tariff regulates the general right to use the network and, according to Calvo et al (2006), takes into account the costs related to administrative management procedures associated to the infrastructure manager’s relations with railway operators. These costs include the costs of staff and equipment for their general administration, the publication of the network statement, the elaboration of operating plans, the allocation of capacity and the running of trains supervision. The tariff’s amounts are established in accordance with the estimated yearly level of traffic for a given operator. In total, five different levels of traffic are defined: level N1 for operators with a volume of traffic lower than 1 million train-km per year, level N2.A for operators with a volume of traffic of 1 to 5 million train-km per year, level N2.B for traffic volumes comprised between 5 and 10 million train-km per year, level N3.A for volumes of 10 to 15 million train-km per year and level N3.B for higher volumes of traffic. Tariffs differ considerably from one level to another (from 60.000 €/year to 1.400.000 €/year for levels N1 and N3.B, respectively), due to the non linearity of this scheme.

On the other hand, the capacity reservation tariff (imposed for the availability of the requested route and set according to the fixed maintenance, operation and rail infrastructure management costs) and the traffic tariff (set according to the financial related costs, the fixed assets amortisation costs and, when appropriate, the necessary costs for guaranteeing the reasonable development of railway infrastructure) are also highly differentiated.

Concerning the capacity reservation tariff, the unit values are established according to the train-km reserved, taking into account three different parameters, namely:

- *The type of line*, which reflects the consideration of construction costs: Infrastructure is categorised as type A for new high speed lines, type B for upgraded lines and type C for conventional lines. In 2006, line type A included Madrid-Barcelona (type A.1) and Madrid-Seville (type A.2), even if the Network Statement stated that Madrid-Barcelona would be considered line type A.2 until its construction was completely finished. Line type B included the Mediterranean Corridor, defined as the section between Valencia and Tarragona, and line type C included the rest of Adif's lines. In all cases, tariffs decrease from A.1 to C through A.2 and B.

- *The type of service to be provided and the type of train (top speeds above or below 260 km/h)*, which reflect the ability to pay of faster services, since they usually enjoy a better commercial position: Reservation capacity tariffs vary with the type of service to be provided, either passenger transport, freight transport or test services[72]. The type of passenger service is further divided into two different categories, according to the top speed[73] of the service: type of passenger service V1 for services with top speed equal to or above 260 km/h and type of passenger service V2 for services with top speed below 260 km/h. The tariffs for passenger transport are more expensive than the ones for freight transport.

- *The period of day affected by the reservation*: Reservation capacity tariffs also differentiate tariffs amounts according to the period of day, considering three different options (off-peak, normal or peak periods). Reservation capacity tariffs are considerably higher for peak periods than for off-peak periods (with the exception of test services, which pay the same tariff regardless of the period of the day affected by the reservation). This differentiation in time periods could be interpreted as reservation capacity tariffs considering a congestion component or the ability to pay of the market. Furthermore, it should be added that the stopping time at the previous station is the one considered for the purposes of the tariff application according to the period of the day; therefore, the reservation capacity

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[72] Test services correspond to train operations carried out to adapt and measure new or existing vehicles, which need service entry or operating licences, as well to calibrate any of their components (Adif, 2005).

[73] Top speed is understood to be the maximum effective speed in the corresponding service (Adif, 2005).

> tariff could incentivise operators towards specific stop patterns (CENIT et al, 2007a) or incentivise them to plan train departures at off-peak hours.

The consideration of the market's ability to pay being gauged by the capacity reservation tariff is considerable as confirmed by the fact that services reaching 260 km/h on high speed lines during peak periods will have to pay amounts almost five times higher than if the run took place at off-peak periods.

With regard to the traffic tariff, set according to the financial related costs, the fixed assets amortisation costs and, when appropriate, the necessary costs for guaranteeing the reasonable development of railway infrastructure, it is clearly a mark up for high speed services and a higher one for those running at peak hours, since it only applies to high speed lines (passenger services[74] with top speeds above 260 km/h) and it varies with the time period. Furthermore, it reflects the service commercial value, by taking into account the transport capacity offered (seats-km).

With regard to track access to services facilities and supply of services, special mention must be made to the tariff for station use. Its value is fixed per passenger and varies depending on the class of the station where the trains stop and on the distance travelled. With regard to stations, three different station classes are distinguished. The more expensive one (class 1) includes 6 stations, all of which are connected to the Spanish high speed lines (Madrid-Puerta de Atocha, Barcelona-Sants, Córdoba, Lleida, Sevilla-Santa Justa and Zaragoza-Delicias) and are used by almost all high speed services connecting Madrid with Seville and Barcelona. Concerning the distance travelled, four different tariffs are established according to the length of the route (route of more than 250 km, route comprised between 126 and 250 km, 80 km and 125 km or shorter than 80 km). It has to be noted that high speed services are characterised by a higher load factor than other medium and long distance services, higher travel distances and stops at first category stations. Therefore, tariffs for station use seem to be set to reflect the rather favourable commercial position of high speed services and their ability to pay higher charges.

Passenger transport security fees seem to follow a similar pattern to the tariff for station use. Indeed, the fee is also fixed per passenger and varies depending on the distance travelled, although in this case only three categories are defined: route services covering less than 150 km, between 150 and 300 km or more than 300 km, with all international services explicitly included in the last category. Therefore, international services seem to be penalised.

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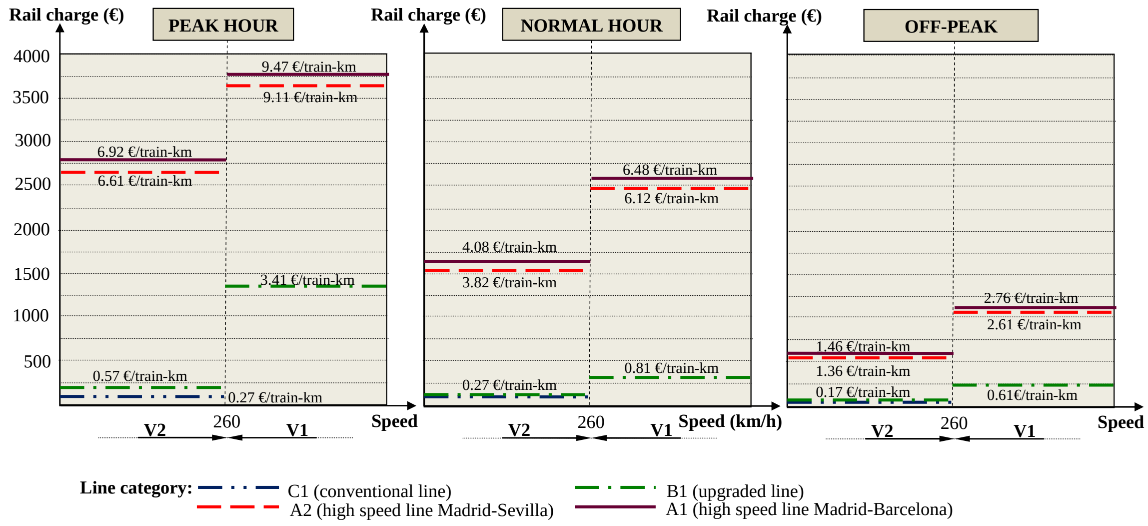
[74] Since Spanish high speed lines are currently only used by passenger trains.

The structure of charges presented in the preceding paragraphs gives rise to a two part tariff structure where the variable component of the charge amounts to approximately 99,9% of the total charge for all high speed links analysed[75] (Madrid-Toledo, Madrid-Saragossa, Madrid-Seville, Madrid-Barcelona and Barcelona-Seville). **Figure 4.2** summarises the unit level of charges for the Spanish railway network, resulting from the charging system described.

FIGURE 4.2 LEVEL OF CHARGES FOR THE SPANISH RAILWAY NETWORK IN 2006
Source: Sánchez-Borràs et al (2009).



Remarks:
- Values obtained considering a level of traffic above 15 million train-km/year (and the real number of train-km for the national Spanish operator, Renfe, to be 180 million train-km/year approximately) and a length of line of 400 km.
- Charges for Stations and Security Fee not included.

4.2.3. German rail infrastructure charging system

The current German infrastructure manager, DB Netz AG, is a subsidiary of DB AG Holding, created in 1994 as a public limited company, succeeding the previous German railway companies, Deutsche Bundesbahn and Deutsche Reichsbahn. In the same year, DB AG opened its infrastructure to new entrants and introduced the first German infrastructure charging system in order to regulate the use, by railway operators, of the infrastructure managed by DB Netz AG.

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[75] In order to allocate the fixed charge to each of the links considered, the value given by Adif was divided by the total train-km run in 2004 in the corridor analysed and multiplied by the length of the link for which the infrastructure charge was to be calculated.

The legal framework for rail infrastructure charging is defined in Art. 14 of Germany's General Railway Act (AEG), which states that "infrastructure managers have to calculate their infrastructure charges (....) in such a way that their costs (plus a return on investment which can be borne by the market) can be covered".

The costs to be covered by DB Netz AG and therefore to be borne by the railway undertakings through infrastructure charges are the costs of network operation, maintenance, administration, and the remainder of the costs connected to infrastructure investment after State contributions (Ludwig, 2006), which partly covers investment expenditures and renewal costs. CEMT (2005) states that noise costs are also partly covered by infrastructure charges.

Therefore, the German infrastructure pricing system aims to full cost recovery (taking into account State grants and interest-free loans) for the minimum access package. According to CEMT (2005), 60% of infrastructure expenditure (including loans and grants) is covered by rail infrastructure charges. According to Railimplement, there is strong evidence of high speed trains not covering their true (incremental) infrastructure costs when operating on dedicated lines with maximum speeds above 250 km/h.

The current German infrastructure charging system differentiates between pricing systems for train paths, facilities (stations and terminals) and additional services.

The current pricing system for train paths, introduced in 2001, is known as Train Path Pricing System 2001 (TPS 2001). This system has been set so that it "takes into account both the infrastructure costs generated by customer requirements and the financial situation of the respective user groups" (DB Netz AG, 2007) and in a way that all customers pay the same price for the use of identical services (train path products), ensuring a non-discriminatory acces to rail infrastructure. According to DB Netz AG network statement, with the purchase of a path all standard services are covered.

In annex A3 the structure and the tariffs of the TPS have been summarised according to the data published in DB Netz AG's 2006 Network Statement. It can be seen that the single-stage Train Path Pricing System contains three modular pricing determinants:

- Line category and utilisation
- Train path products
- Supplements and deductions

In 2008, these three determinants were reorganised into a usage-based component (which takes into account the line category as well as the train path products), a performance-based component (where the utilisation factor is considered) and other charge components (which comprise supplements and deductions). Infrastructure charges for the minimum access services are calculated as the product of these three components.

With regard to the usage-based component, it is made up of a base price and a train path product. The base price is determined by the quality of the route and expressed per train path-kilometre. Specifically, the network has been divided into sections and each one has been assigned one class of route availability. In total 12 different classes of route availability have been defined (Fplus, F1, F2, F3, F4, F5 and F6 for long distance lines; Z1 and Z2 for feeder lines; and S1, S2 and S3 for urban rapid transit lines), taking into consideration objective line features, i.e. a “specific, expense-item infrastructure fitments as well as the significance in traffic terms that each section has for users as part of the overall network” (DB Netz AG, 2007). As a result of this, the price differentiation is market-driven.

Out of these 12 classes of route availability, two are mainly intended for high speed traffic, namely:

- *Category Fplus lines (High speed lines),* which are those of above-average importance in traffic terms and which can be worked at speeds above 280 km/h for the most part.

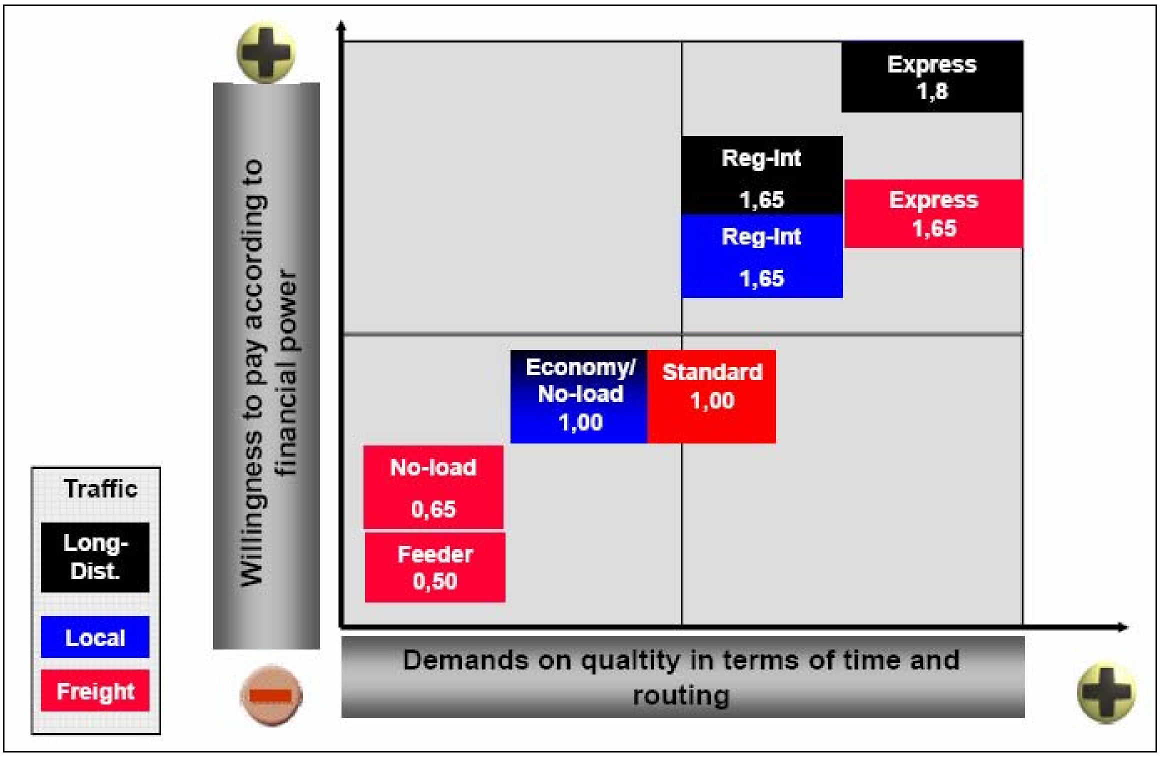
- *Category F1 lines (High speed lines)*, which combines all lines that can be worked at speeds between 200 km/h and 280 km/h.

The base price attributed to categories Fplus and F1 (new lines, i.e. high speed lines) is much higher than the one for the other classes of route availability (8,30 and 3,79 €/train path-km versus 1,46 to 2,51 €/train path-km for the other classes).

The train path products, which complete the usage-based component, enable the train path system to adjust to differing market needs (DB Netz AG, 2007), correspondingly ensuring a market focus. These multipliers of the base price are divided into five pathing products for passenger traffic (express path, long distance regular interval path, local regular interval path, economy path, light running passenger service path) and four pathing products for freight traffic (express path, standard path, out-of-gauge path, light running freight path).

The level of the product factor is determined by the costs caused by customer's requirements and quality and the willingness to pay, i.e. the impact of charge levels on the competitiveness of RUs. **Figure 4.3** shows that express paths and long distance regular interval paths are the ones where the willingness to pay and quality demands in terms of time and routing are the highest. It needs to be highlighted that high speed services are specifically prone to use these two categories of passenger traffic paths.

FIGURE 4.3 DETERMINATION OF THE LEVEL OF THE PRODUCT FACTOR
Source: Bohrer (2004)

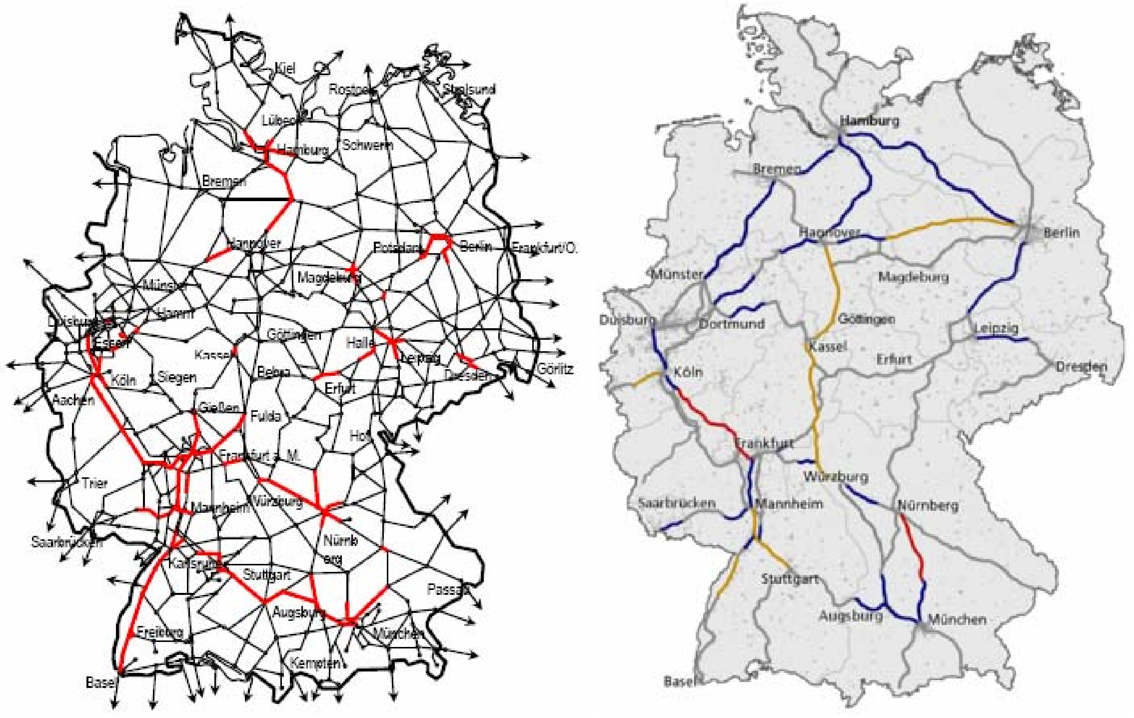


Concerning the performance-based component, referred to as a utilisation factor, it is meant to raise the efficiency of the route network; that is to say, it acts as an incentive to raise capacity performance. According to the German network statement, it only applies to very busy lines for which there are alternative routes, enabling better capacity management and a redirection of traffic flows towards routes with low traffic volumes. Therefore, congestion is considered in the charging system by means of a mark up.

This utilisation factor charges a supplement of 20% for routes with extremely high utilisation, which often coincide with new lines (high speed lines –HSL–) or upgraded lines (see **figure 4.4**).

Finally, the variable "other charge components" includes special factors, which augment the regular path price. No in-depth comment will be made of those components, since none of them is especially relevant in high speed services[76].

FIGURE 4.4 GERMAN RAIL ROUTES WITH EXTREMELY HIGH UTILISATION (left) AND HIGH SPEED LINES (right)
Source: Own from Bohrer (2004) and Wikimedia Commons (2008)



Remarks:
- In red, routes with extremely high utilisation

Remarks:
- In red, HSL allowing speeds of 300 km/h
- In yellow, HSL allowing speeds equal to or above 250 km/h
- In blue, upgraded lines allowing speeds equal to or above 200 km/h
- In grey, conventional lines, sometimes upgraded to run with speeds up to 160 km/h

With regard to the charging of facilities (stations and terminals), stops at stations are charged according to their geographical location (federal Länder) and to six different categories (long distance transport nodes –1–; stations belonging to the long distance system –2–; local transport nodes with, eventually, long distance stations –3–; very busy local transport stations –4– (local transport nodes); stations of the local transport system –5–; and local transport stations –6–), category 1 being the most expensive one and

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[76] On the one hand, the load component only applies to freight traffic and reflects the additional expenditure that heavy trains cause through increased wear and capacity consumption; on the other hand, the regional factor only affects local passenger trains.

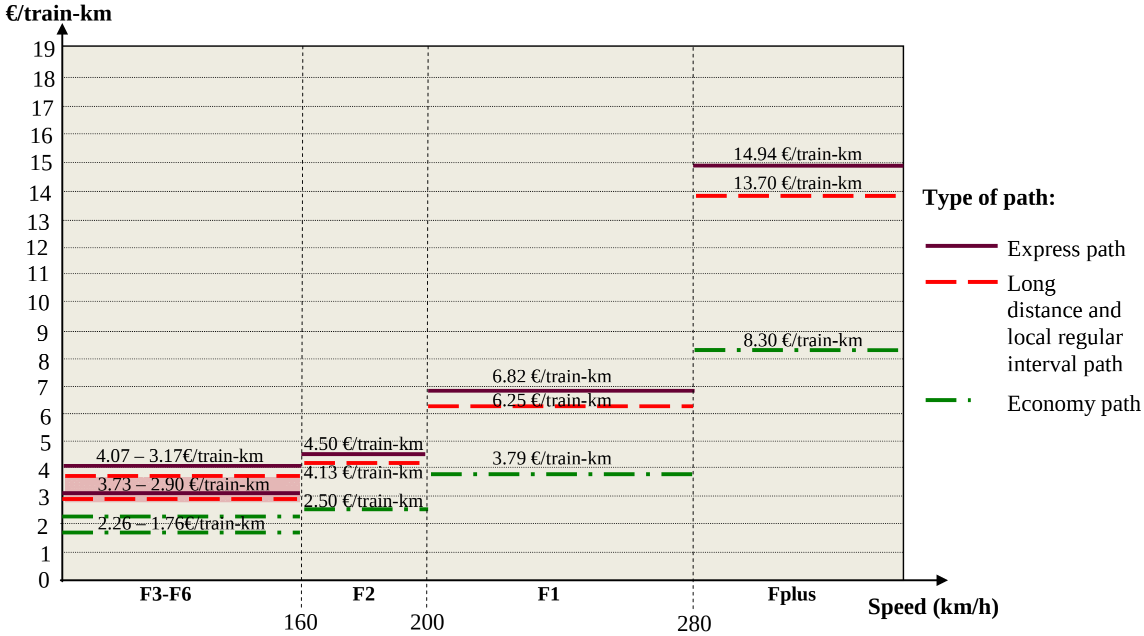
category 6 the cheapest one in each federal Land (see **table 4.3**). Those prices are modified with a factor taking into consideration the length of the train (factor 1 for trains shorter than 180 m and factor 2 for trains longer than 180 m). Since high speed trains use mainly station categories 1 and 2 (sometimes category 3 too), it could be considered that stations are charged according to the ability to pay of the market. Furthermore, the system incentivises to run frequent short trains, rather than sporadic long trains.

TABLE 4.3 CHARGING OF FACILITIES (STATIONS AND TERMINALS) FOR THE YEAR 2006
Source: Sánchez-Borràs from DB Netz AG's Network Statement for the year 2006

Federal Länder	Station category (prices in €)					
	1	2	3	4	5	6
Baden-Württemberg	14,82	11,74	6,87	1,47	2,31	2,03
Bayern	14,51	12,22	8,54	1,44	2,32	2,01
Berlin	13,96	6,59	8,38	1,01	3,10	
Brandenburg		25,65	19,94	2,74	6,95	3,44
Bremen	29,73		17,17	2,55	5,86	2,72
Hamburg	14,71	10,28	5,70	2,58	3,16	
Hessen	18,71	15,81	4,65	1,85	2,37	2,32
Mecklenburg-Vorpommern		27,98	18,80	1,28	9,03	2,72
Niedersachsen	26,31	16,61	6,53	1,96	2,75	2,61
Nordrhein-Westfalen	16,82	14,31	5,81	1,89	2,83	2,79
Rheinland-Pfalz	21,68	18,81	9,56	1,31	1,73	1,47
Saarland		26,17	6,86	1,09	1,46	1,25
Sachsen	40,01	28,39	18,58	2,05	3,71	2,36
Sachsen-Anhalt		34,64	10,15	1,91	2,83	2,23
Schleswig-Holstein		31,02	8,10	1,76	4,06	2,56
Thüringen		24,64	17,25	1,67	4,22	1,78

From the paragraphs above it can be concluded that the German charging system applies mark ups to high speed lines and differentiate by category of passenger trains and location. However, those mark ups do not strictly follow the Ramsey-Boiteux principle. **Figure 4.5** summarises the level of charges resulting from the pricing system just described.

FIGURE 4.5 LEVEL OF CHARGES FOR THE GERMAN RAILWAY NETWORK IN 2006
Source: Sánchez-Borràs et al (2009).



Remarks:
- The consideration of busy sections requires to multiply the given values by a coefficient 1.20 (20% increase).
- Charges for Stations not included.

4.2.4. Italian rail infrastructure charging system

The current Italian infrastructure manager, *Rete Ferroviaria Italiana SpA* (RFI), was created in 2001 as a result of the restructuring of the Gruppo Ferrovie dello Stato (a 100% State owned holding) defined by Decree 168/T of 31st October 2000. Since then, infrastructure charges are charged to railway operators, Trenitalia, the State-owned-operator, being the main one.

The determination of the Italian charging system is defined by the Legislative Decree N. 188 of 8th July 2003 (DLgs 188/03), which transposed Directive 2001/14/EC (as well as the other two Directives of the First Railway Package) into national law. According to DLgs 188/03, the acceptance of an infrastructure management proposal must be subject to an examination by the Ministries' Board for Economical Planning (*Comitato Interministeriale per la Programmazione Economica*, CIPE), a pan governmental institution that decides on the appropriateness of implementing it through an infrastructure/transport ministry legislative decree. Currently, the legal framework for rail infrastructure charges is set by the Ministry Decrees DM 43/T of 21st March 2000 and Decree DM 44/T of 22nd March 2000. The first one defines the charging principles and presents the formula for calculating the charge for the Minimum Access Package[77]. The second one establishes a temporary discount, aimed at partially compensating the higher costs incurred in connection with the technological underdevelopment of the railway network.

Infrastructure charges for the use of the Italian railway network cover the full cost after State grants. Specifically, out of all infrastructure management costs, infrastructure charges paid by railway operators to RFI cover part of the running cost (all traffic management costs –a share of direct and indirect overheads relating to traffic movements, the costs of electricity for electric traction, as well as scarcity/congestion costs– and part of IM’s salary costs), while maintenance costs are covered by the State, by means of a public service contract (*Contratto di Programma*) renewed every five years. The State also covers the full costs of renewals and investment and the part of salary costs not covered by infrastructure charges. Accidents, pollution and noise costs are neither covered by infrastructure charges nor the State.

According to CEMT (2005) “the basic approach taken to charging in Italy is described by RFI as being based on short-run marginal cost”. Nevertheless, figures cited on the same source regarding the recovery of total costs from access charges for the year 2004 (cost recovery rate of 16%, which represents approximately a third of routine maintenance costs) showed that the Italian charging approach fails to recover important elements of marginal cost, namely maintenance and renewals.

Infrastructure charges can be divided into charges for the minimum access package, for mandatory services, for complementary services and for ancillary services. For the services not included in the access charge, the amount to be paid by RUs are determined according to the resources used and other costs supported by RFI for the supply of those services.

Infrastructure charges for the minimum access package consist on an access charge to which some discounts can be applied according to Decree DM 44/T of 22nd March 2000. Since these discounts only apply to lines with technological underdevelopment, which is not the case of high speed lines, they will not be treated in detail in this report. Nevertheless, it is important to highlight that the lines with a top speed above 200 km/h are partly subsidised through this discount, even if DM 44/T means it to compensate the

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[77] Its values are updated in subsequent decrees: Decree of 11 April 2003 (Gazzetta Ufficiale della Repubblica Italiana, Serie Generale, N. 114 of 19 May, 2003), Decree of 15 July 2003 (Gazzetta Ufficiale della Repubblica Italiana, Serie Generale, M. 174 of 29 July, 2003) and Decree of 24 March 2005 (Gazzetta Ufficialeº, N. 91 of 20 April, 2005). The most recent update is found in Ministry Decree of 18 August 2006, the values of which apply to the year 2007. Therefore, the values published in it will not be analysed in this report, since the research concentrates on rail infrastructure charges in Europe for the year 2006.

technological backwardness of the network (CENIT et al, 2007a).

In terms of charging for the minimum access package, the Italian network has been categorised in:

- Trunk lines: 78 sections
- Main nodes: 8 nodes
- Complementary lines: secondary lines (191 sections), low traffic lines (42 sections) and shuttle lines (15 sections)

This categorisation is meant to reflect the quality of each part of the Italian railway network (number of tracks, speed and technological equipment).

The structure and the tariffs of the Italian access charge (on the basis of the data published in RFI’s 2006 Network Statement) is presented in annex A3. In Italy, the charge for the use of the infrastructure is composed of:

- *A charge per section/node ($R_{section/node}$)*: a fixed charge which corresponds to the access cost for each section or node.

- *A charge per kilometre/minute ($R_{km/minutes}$)*: a variable charge which is intended to reflect the cost of the use of the infrastructure contingent on the distance run in each section and the minutes spent within a node.

- *A charge for power consumption ($R_{power\ consumption}$)*: a variable charge which corresponds to the cost of using traction electric power.

The fixed charge of the Italian two-part tariff charging structure varies according to the characteristics of the route used (trunk lines and complementary lines), taking into account the quality of the railway infrastructure depending on the maximum speed and the technical layout of the line. Specifically, four different values have been established for trunk lines:

- *One for double track lines with maximum speeds up to 250 km/h (64,56 €/section[78])*: The only line that belongs to this category is the Direttissima line (high speed rail link between Florence and Rome), the first Italian high speed line.

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[78] The values presented in the text for the Italian network correspond to the ones defined by the Decree of 21 March 2000. Their update for 2005 requires to increase the stated value by 1,4% and again 1,7% to take into account the inflation rate published in the Decrees of 15 July 2003 and 24 March 2005 (Gazzetta Ufficiale della Repubblica Italiana, 2000, 2003, 2005).

- *One for double track lines with maximum speeds up to 200 km/h (56,81 €/section)*: In this category we find five different sections, namely the Rome-Naples high speed line and four sections that are projected to be new or upgraded lines in a near future: Bologna-Milan, Bologna-Florence, Salermo-Paola and Paola-Reggio Calabria Centrale.

- *One for double track lines with maximum speeds lower than 200 km/h (54,23 €/section).*

- *Another one for single track lines (49,06 €/section).*

The fixed charge is paid for each node and trunk line, but only once for all secondary lines (RFI, 2004b). Four different values are applied to trunk lines. According to Nash (2004), this charge, which includes also a train-path reservation charge, may deter some operators from entering the market at all, since it has to be paid by all operators.

The variable part of the Italian access charges ($R_{km/minutes}$ and $R_{power\ consumption}$) also varies according to the characteristics of the route used (trunk lines, complementary lines and nodes).

With regard to $R_{km/minutes}$, the calculation of the different parts of the network follows different patterns:

- For *trunk lines*, the charge is calculated as the sum of three parameters: the first one (P_{speed}) takes into account the inefficient use of capacity (congestion), by determining the deviation between the commercial speed of the train in relation to the average speed defined for the section; the second one ($P_{density}$) takes into consideration the traffic demand, distinguishing between time periods; finally, the third one (P_{usage}) takes into account the wear and tear (of both track and electrical wire) caused by the rolling stock, considering its running speed and weight. All three parameters vary according to the number of kilometres run on each section.

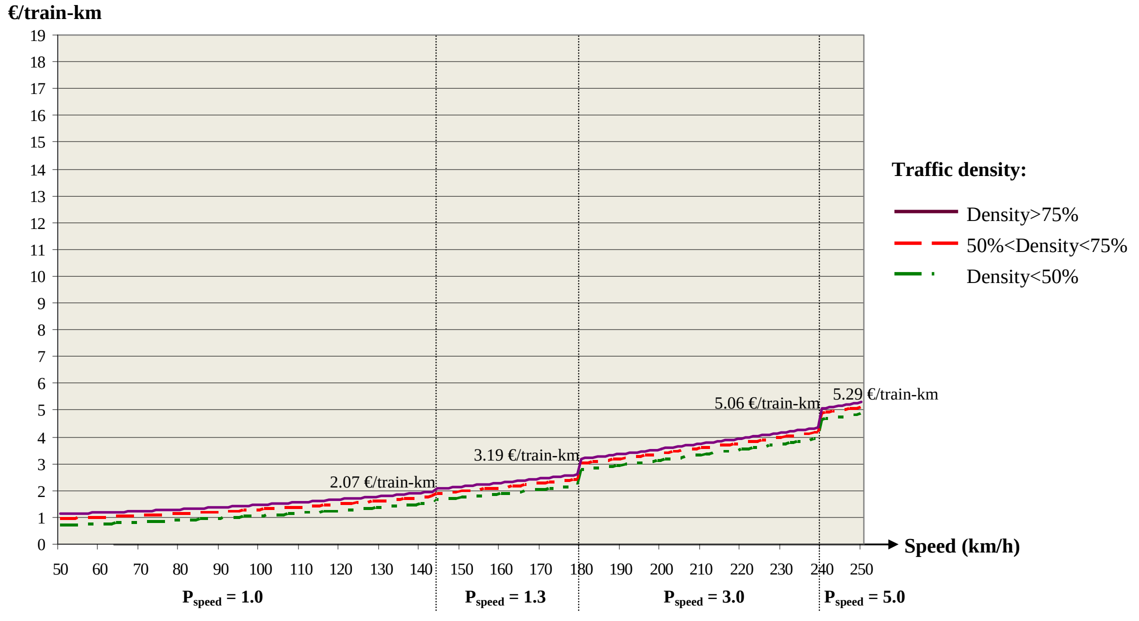
- For *complementary lines*, the price only takes into account the number of kilometres run. Therefore, neither congestion nor traffic demand are considered.

- For *nodes*, the price varies with the number of minutes spent in a node and with the time period (peak hour –from 6 to 9 a.m. –, semi-peak hour –9 a.m. to 10 p.m. and night –22 p.m. to 6 a.m.–) in which the node is used, peak periods being the most expensive ones and night periods the cheapest. Therefore, this charges could be reflecting congestion in some nodes of the network.

TABLE 4.4 WEIGHT OF THE FIXED AND VARIABLE CHARGES FOR ITALIAN NATIONAL HIGH SPEED LINKS
Source: Sánchez-Borràs from RFI's Network Statement 2006 (RFI, 2004)

Link	Fixed charge		Variable charge	
	In €	% fixed/total	In €	% variable/total
Firenze – Milano	223,7 €	19,9 %	898,4 €	80,1 %
Roma – Firenze	173,1 €	17,5 %	816,1 €	82,5 %
Roma – Napoli	165,1 €	15,7 %	886,0 €	84,3 %
Milano – Genova	218,3 €	30,0 %	508,4 €	70,0 %

FIGURE 4.6 LEVEL OF CHARGES FOR THE ITALIAN RAILWAY NETWORK in 2006
Source: Sánchez-Borràs et al (2009).



Remarks:
- Calculations made considering a length of line of 400 km (in order to distribute the access charge per train-km)
- Calculations valid for a train of 430 tonnes (TGV Duplex) with 2 pantographs, running on a line with a reference speed of 120 km/h (speed allowed on the Direttissima line between 6 a.m. and 9 a.m.)
- The value considered for the access charge is the one for the Dirrettissima line for speeds above 200 km/h and the one for double track lines with maximum speeds of 200 km/h for speeds below 200km/h.
- Charges for Stations not included.

The facts above show that the variable charge per kilometre/minute ($R_{km/minutes}$) reflects the marginal wear and tear and congestion costs and, by means of the consideration of the traffic demand according to three different time periods, includes a mark up according to Ramsey pricing on the ability to pay as well.

With regard to $R_{power\ consumption}$, it is charged according to the number of kilometres run.

The structure presented in the preceding paragraphs outlines a two-part tariff structure where the variable component of the access charge has a weight of around 82-84% for trains running on high speed lines (see **table 4.4**), and to the level of charges summarised in **figure 4.6**. It needs to be highlighted that, in the Italian scheme, the mark ups applied are not always higher for high speed lines than for conventional lines.

4.2.5. Belgian rail infrastructure charging system

In 2005, the Belgian State railway administration SNCB was restructured into a holding company (SNCB-Holding) with two subsidiaries: Infrabel, the current infrastructure manager, and SNCB, the current State-owned railway operator.

The conditions of use of Infrabel's infrastructure by railway operators (principles and procedures for charging the use of railway infrastructure) are defined by decree law in the "Arrêté royal créant le Service de Régulation du Transport ferroviaire et fixant sa composition ainsi que le statut applicable à ses membres", which transposes some provisions of Directive 2001/14/EC.

According to CEMT (2005), the Belgian charging system is FC- with a linear tariff per train-km and has a cost recovery rate of total infrastructure expenditure (including loans and grants) of 20%.

The structure of the Belgian charging system for 2006 is composed of a train path-line charge for having access to and using the lines, a train path-facility charge for having access to and using tracks with platforms and certain arrival and departure tracks, a shunting charge and administrative costs for the handling of capacity applications (see annex A3).

The train path-line charge for having access to and using the lines (infrastructure charges for the minimum access services) is calculated as the product of a base price P (revised and established every year on 1st January according to a weighting of the "sanity price index" (65%) and the "services price index" (35%)) and seven coefficients:

- *Environmental incidence coefficient (Ce)*: this coefficient is supposed to reflect the environmental impact of rail transport. Nevertheless, this value does not currently affect the amount of infrastructure charges, since it equals 1. According to the network statement, this will remain so until other modes of transport are also charged for the environmental impact they inflict.

- *Category of running priority (Pt)*: Six running priority categories are defined according to the quality of the service offered by the IM and specifically according to the level of priority assigned to a train with regard to other trains in case there are some traffic disturbances. Categories 1 and 2, which correspond to those assigned to high speed trains and classic international passenger trains, are the ones to which a higher running importance is assigned, and those for which the coefficient value is the highest (increase of 50%). This coefficient might reflect the commercial position of the different services.

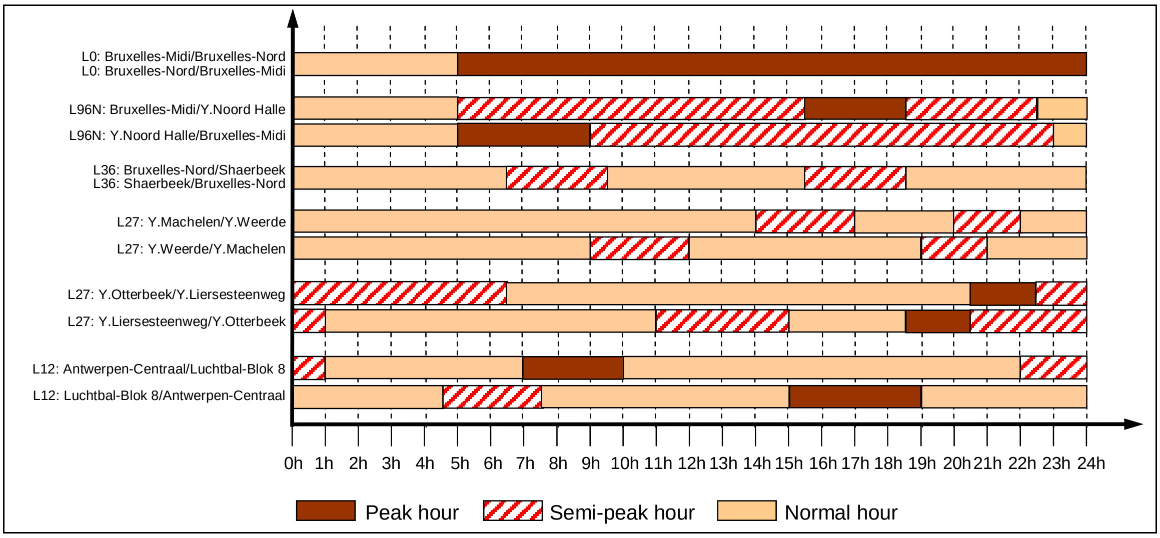
- *Category of admissible weight on track (C)*: Infrastructure is divided into five categories depending on the admissible weight on track: 0-400 tonnes, 401-800 tonnes, 801-1200 tonnes, 1201-1600 tonnes and 1601-2000 tones. This could be interpreted as a way of considering wear and tear costs. However, since this system implies that the weight of the train is charged according to a non-linear scheme, it could be rather reflecting the costs of planned maintenance and renewals. It should be noted that a high speed train such a TGV Duplex weights 430 tonnes and, therefore, would be classified in category 2, which implies an increase of the base price of 55%.

- *Category of line (C1(i) –operational importance of the section– and C2(i) –technical equipment of the section–)*: On the one hand, coefficient C1(i) divides infrastructure into five different categories according to the operational importance of the sections. The criteria used for this categorisation is not specified in the network statement. On the other hand, coefficient C2(i) divides infrastructure according to the maximum speeds allowed by the technical equipment of the section. Category 1 applies to reference speeds above 220 km/h. The other categories group speeds into the following intervals: 160-220 km/h (including the Nord-Midi junction), 140-160 km/h, 120-140 km/h, less than 120 km/h, industrial lines and lines with restricted operation. Values for speeds above 220 km/h are considerably higher than the ones applied to lower speeds. According to Railimplement, both coefficients C1(i) and C2(i) can be seen as a proxy for congestion costs.

- *Time period (category H(i))*: Three time periods are defined for the Belgian network (important or peak hour, medium or semi-peak hour and normal hour). As **figure 4.7** shows, its definition varies not only with the time of the day, but also with the line and running direction. This differentiation by time period, line and direction of running could be reflecting the ability to pay of certain services.

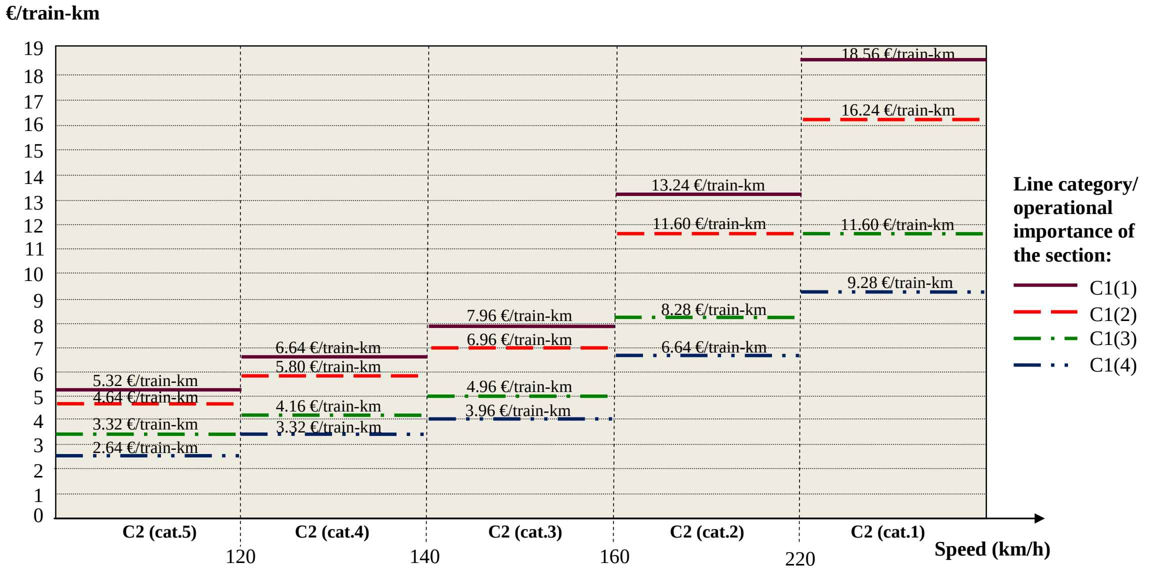
- *Deviation coefficient with regard to the standard train-path contingent on the difference between the train-path running time on the line section and the standard running time (T(i))*: This coefficient reflects the punctuality of the services. The non punctuality of passenger trains is penalised to a greater extent for passenger services than for freight services. For instance, passenger trains are penalised for deviations from 5,01% with regard to the standard train path, while penalties for freight trains apply only if deviations in time journey exceed 100%. Therefore, railway operators are incentivised to minimise time deviations from the agreed train-path.

FIGURE 4.7 TIME PERIOD DEFINITION SECTIONS OF THE BELGIAN NETWORK PERTAINING TO THE LILLE-BRUSSELS-AMSTERDAM CORRIDOR
Source: Adapted from Sánchez-Borràs et al. (2008a)



From the information above it can be concluded that these coefficients cover the key drivers relating to marginal costs (weight of the train, wear and tear on the network, etc) as well as other parameters (e.g. environmental coefficient and coefficients that relate to the congestion) that compose the social marginal costs of running a train. Furthermore, the coefficients include a differentiation by broad category of passenger train (coefficient Pt) and time of day (coefficient H(i)), which may be reflecting the ability to pay of certain services. **Figure 4.8** summarises the level of charges resulting from the pricing system described.

FIGURE 4.8 LEVEL OF CHARGES FOR THE BELGIAN RAILWAY NETWORK in 2006
Source: Sánchez-Borràs et al (2009).



Remarks:
- Values applicable to high speed trains and classic international passenger trains (weight comprised between 401-800 tonnes) considering a punctual service running at peak hours.
- The values for normal and off-peak hours can be obtained dividing the values presented by 4/3 and 4, respectively.
- Charges for Stations not included.

The train path-facility charge for having access to and using tracks with platforms and certain arrival and departure tracks is made of the sum of two components: a base price increased by coefficients reflecting the nature of the use of a station (Cu) and the operational importance of the station and its equipment (C(i)), and the same base price increased by coefficients reflecting the operational importance of the station and its equipment (C(i)) and the time spent in the station. Therefore, this charge may be considering both the ability to pay for certain services and congestion.

Base prices differ by type of service (passenger, freight), the one for freight trains being 1,25 times higher than the one for passenger trains.

Concerning the nature of the use of stops, the Network Statement defines four different types of stops: origin, destination, intermediate commercial stop and stop of service. This categorisation may incentivise the operation of direct trains rather than trains with intermediate commercial stops. Nevertheless, it does not incentivise, according to CENIT et al (2007a), to optimise RU's operation at origin and destination stations, since the coefficient for origin and destination stations is not contingent on the time spent in those by the train.

As per the operational importance of the station and its equipment, it depends on the category of the station, as well as on the type of traffic (passenger trains, freight trains). The classification of stations established in the Network Statement reflects the importance of each station, high speed terminals (Terminal TGV Bruxelles-Midi TGV train-path) being the stations that increase the base price the most. The type of traffic considerably influences the value of the train path-facility charge for passenger services. Indeed, passenger services using the TGV Terminal Brussels-Midi TGV train-path will be increased by a C(i) coefficient equal to 20,0.

The weight of train path-facility charges compared to the total charge to be paid by a high speed train can be significant. For instance, a railway operator offering a high speed service from Brussels to Cologne will have to pay a charge for using the station in Brussels almost as expensive as the charge to be paid for running on the 147 km of track that separate Brussels from the Belgian-German border in Hergenrath. In the case of the Lille-Brussels link, out of the total 1.157,7 € to be paid for running a high speed train on it, 553 € are to be paid for using the Brussels-Midi station.

4.3. SUMMARY OF THE MAIN CHARACTERISTICS OF THE EUROPEAN PRICING SYSTEMS FOR HIGH SPEED SERVICES IN TERMS OF THE APPLICATION OF MARK UPS ABOVE MARGINAL COST

The results presented in the preceding section show that rail infrastructure charging systems implemented in European countries with high speed lines in operation correspond to a second-best charging strategy. On the one hand, France and Spain apply mark ups to social marginal cost (MC+). On the other hand, Germany, Italy and Belgium follow a pricing policy consisting of collecting the full financial cost minus subsidies (FC-). However, it has to be stressed that although Italy nominally uses FC-, the basic approach taken to charging is described as being based on short-run marginal cost (CEMT, 2005).

For those charging systems based on marginal cost, the rail access charging consists of additive charging components (see **table 4.5**), with a fixed and a variable component (two-part tariff); France and Spain both have reservation charges as well. The weight of the variable and fixed parts is presented in **table 4.6**.

With regard to the charging systems based on the collection of the full financial cost minus subsidies (FC-), the rail access charging consists of a base price multiplied by different coefficients (see **table 4.7**). The charging structure is therefore a linear tariff.

TABLE 4.5 **UNIT VALUES CHARGED TO HIGH SPEED SERVICES FOR USING THE EUROPEAN HIGH SPEED LINES (2006 VALUES). CASE OF ADDITIVE CHARGING SYSTEMS**

Country	Type of charge (values given in €/train-km)				
	(Fixed) Access charge	Reservation/ capacity charge	Running charge	Electric traction facilities	Other
FR	0,946	0,0896 – 5,366 1,894 –10,739 3,565 –12,870	0,944	0,442	
ES	Lump sum	0,65 – 0,75 1,00 – 2,20 2,00 – 3,40	0,70 – 2,00		Traffic tariff: 0,65 – 1,25 €/100 seats-km
IT	56,81 – 64,56 €/section		1 (multiplied by different factors)	0,332	

Remarks:

- When three rank values are given, the first one corresponds to off-peak hours, the second one to normal hours and the third one to peak hours.
- Station charges have not been considered in this table

TABLE 4.6 **WEIGHT OF VARIABLE AND FIXED CHARGES FOR HIGH SPEED SERVICES Source: Sánchez-Borràs from data from the corresponding 2006 Network Statements, and according to the assumptions presented in chapter 3**

Country	Tariff structure	Weight of:	
		Fixed charges	Variables charges
FR	Two-part tariff	12 – 8 % (for 100% NL)	88 – 92% (for 100% NL)
ES(1)	Two-part tariff	0,1 % (for 100% NL)	99,9 % (for 100% NL)
IT	Two-part tariff	20-16 % (for NL or UL)	80 – 84 % (for NL or UL)

Remarks:

NL: New line
UL: Upgraded line

(1) In order to allocate the fixed charge (published by Adif as a lump sum) to each of the links considered, the value given by the IM was divided by the total train-km run each year in the analysed corridor and multiplied by the length of the link for which the infrastructure charge was to be calculated.

TABLE 4.7 UNIT VALUES CHARGED TO HIGH SPEED SERVICES FOR USING THE EUROPEAN HIGH SPEED LINES (2006 VALUES). CASE OF MULTIPLICATIVE CHARGING SYSTEMS

Country	Base price	Multipliers	
DE	2,50 – 8,30 (€/train-km)	- Utilisation factor on busy sections:	1,20
		- Product factor:	1,65 – 1,80
BE	0,285073 (€/train-km)	- Environmental incidence coefficient (Ce):	1
		- Category of running priority (Pt):	1,50
		- Category of admissible weight on track (C):	1,55
		- Operational importance of the section (C1(i)):	2
		- Technical equipment of the section (C2(i)):	3,5
		- Time period (H(i)):	4
		- Deviation coefficient (T(i)):	1 – 1,45

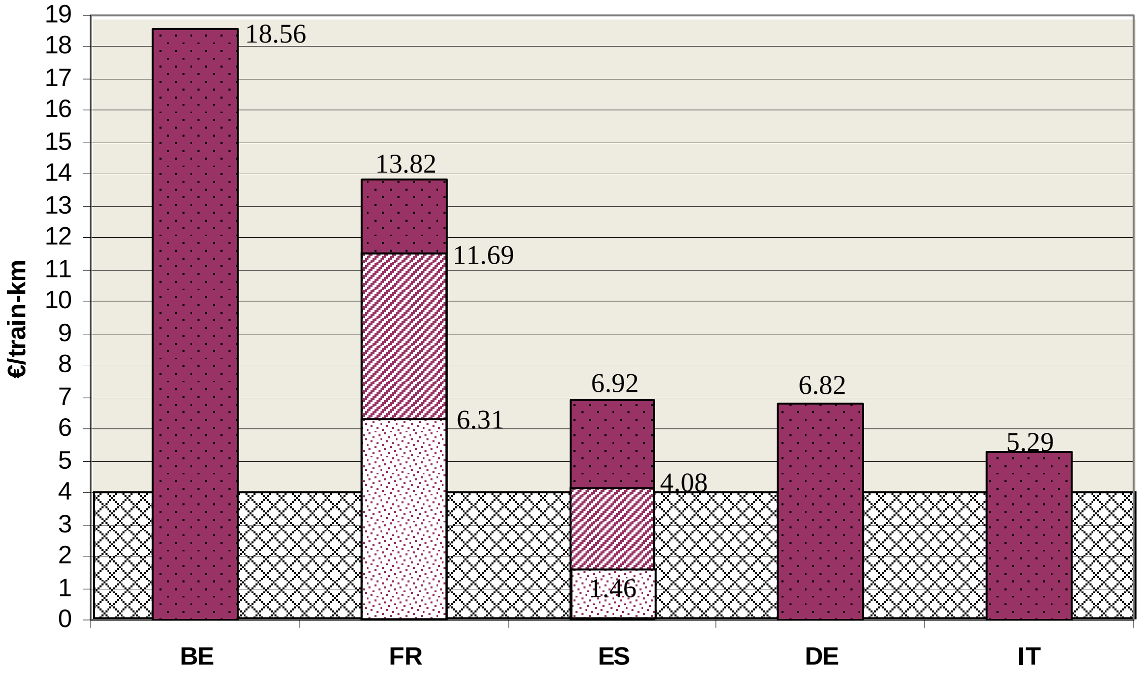
Remarks: Station charges have not been considered in this table.

TABLE 4.8 CHARACTERISATION OF PRICE DIFFERENTIATION APPLIED IN THOSE COUNTRIES WHERE THE CHARGING SYSTEMS ARE BASED ON MARGINAL COST

Country	Differentiation by:		
	Broad category of passenger train	Location	Time of day/week/year
France	Considered indirectly by the definition of the quatility levels of the sections: - Suburban - Intercity - High speed - Regional	Considered indirectly by the definition of subcategories for each category of section, which are defined taking into account the amount of traffic borne (high, medium and low) and, in some cases, also the maximum speed allowed on it.	Time of day: - Peak: 6:30-9:00; 17:00-20:00 - Normal: 4:31-6-29; 9:01-16:59; 20:01-0:30 - Off-peak: 00:31-4:30
Spain	- Passenger trains with top speeds above 260 km/h - Passenger trains with top speeds below 260 km/h	Considered indirectly by the lines' categorisation (new lines –A–, upgraded lines –B–, conventional lines –C–).	Time of day: - Peak: 7:00-9:29; 18:00-20:29 - Normal: 9:30-17-59; 20:30-23:59 - Off-peak: 0:00-6-59
Italy	No differentiation	Considered indirectly by the route category (trunk, complementary, nodes) when defining the traffic density.	Time of day: - Peak: 6:00-9:00 - Normal: 9:00-22:00 - Off-peak: 22:00-6:00

The results presented in the preceding section also show that there seems to be a widespread tendency towards applying higher charges to HSL, i.e. of applying higher mark ups over marginal costs to HSL. These higher charges in those countries charging mark ups to social marginal cost result from the broadly application of Ramsey-Boiteux pricing, differentiating by broad category of passenger train, location and time of day, each country using however its own criteria (see **table 4.8**).

FIGURE 4.9 UNIT VALUES CHARGED TO HIGH SPEED SERVICES RUNNING AT 250 KM/H ON THE BEST HIGH SPEED LINE QUALITY OF EACH COUNTRY WITH HIGH SPEED LINES.
Source: Sánchez-Borràs et al (2009).



Legend:

▩ Peak hour ▨ Normal hour ░ Off-peak hour

▦ Area where marginal costs for high speed railways seem to be comprised (all marginal social costs considered*), according to evidence on marginal cost estimation available up to now.

<u>Remarks</u>:

- Values for a train running at 250 km/h on the best high speed line quality in each country (stops at stations not considered).
- Same assumptions as for figures 4.1, 4.2, 4.5, 4.6 and 4.8.

* According to Nash et al (2006), the probable components of the marginal social cost of rail infrastructure use are usually identified as marginal wear and tear cost, marginal congestion and scarcity costs, marginal environmental costs and marginal accident costs.

The unit values charged to high speed services running at 250 km/h on the best high speed line quality of each country with high speed lines are summarised in **figure 4.9**. This figure shows that mark ups for high speed runs are well above marginal social costs (estimations of marginal social costs for each country do not exist, but considering the upper limit values of the existing evidence on marginal social cost estimation in Europe presented in section 1.4.2, those costs would not exceed 4 €/train-km), as well as above the optimal mark up for high speed lines calculated in section 1.4.2. Furthermore, it shows that the level of mark ups for high speed lines differ from one country to another. This could be due to differences in the level of subsidies in each country (the level of subsidies really allocated to HSL is unknown), as well as to different applications of price discrimination.

Figure 4.10 presents the level of infrastructure charges in different high speed links of the five countries with new high speed lines. It shows that price discrimination results in different levels of charges for high speed links within a single country and that in all cases, the values for representative national high performance links obtained considering the assumption presented in chapter 3, are way above the average charges for passenger railway services published by CEMT (2005), which are higher than (or equal to) 2 €/train-km[79].

Neither how the mark ups are implemented in practice nor how they have been calculated are clearly explained in the public information available. However, the characterisation of the pricing systems for countries with HSL in operation presented in the preceding section contributes to shed light on the concepts to which the mark ups seem to be applied in the different countries. Those are mark ups based on wear and tear costs, mark ups to recover part of the investment costs or mark ups set at a level that the market can bear, taking into consideration the commercial position of HSR (see **table 4.9**). Therefore, infrastructure charges for HSL seem to be a mix of recovery of the capital cost with a mark up on what the market can bear.

The implementation of these mark ups above marginal cost, although based on the ability to pay in all countries, is done very differently from one country to another (**table 4.9**). However, some common features can be identified:

- *On the one hand, major mark ups above marginal costs are applied to high speed lines*: important mark ups on the marginal cost are applied to high speed lines with the aim of assisting with cost-recovery.

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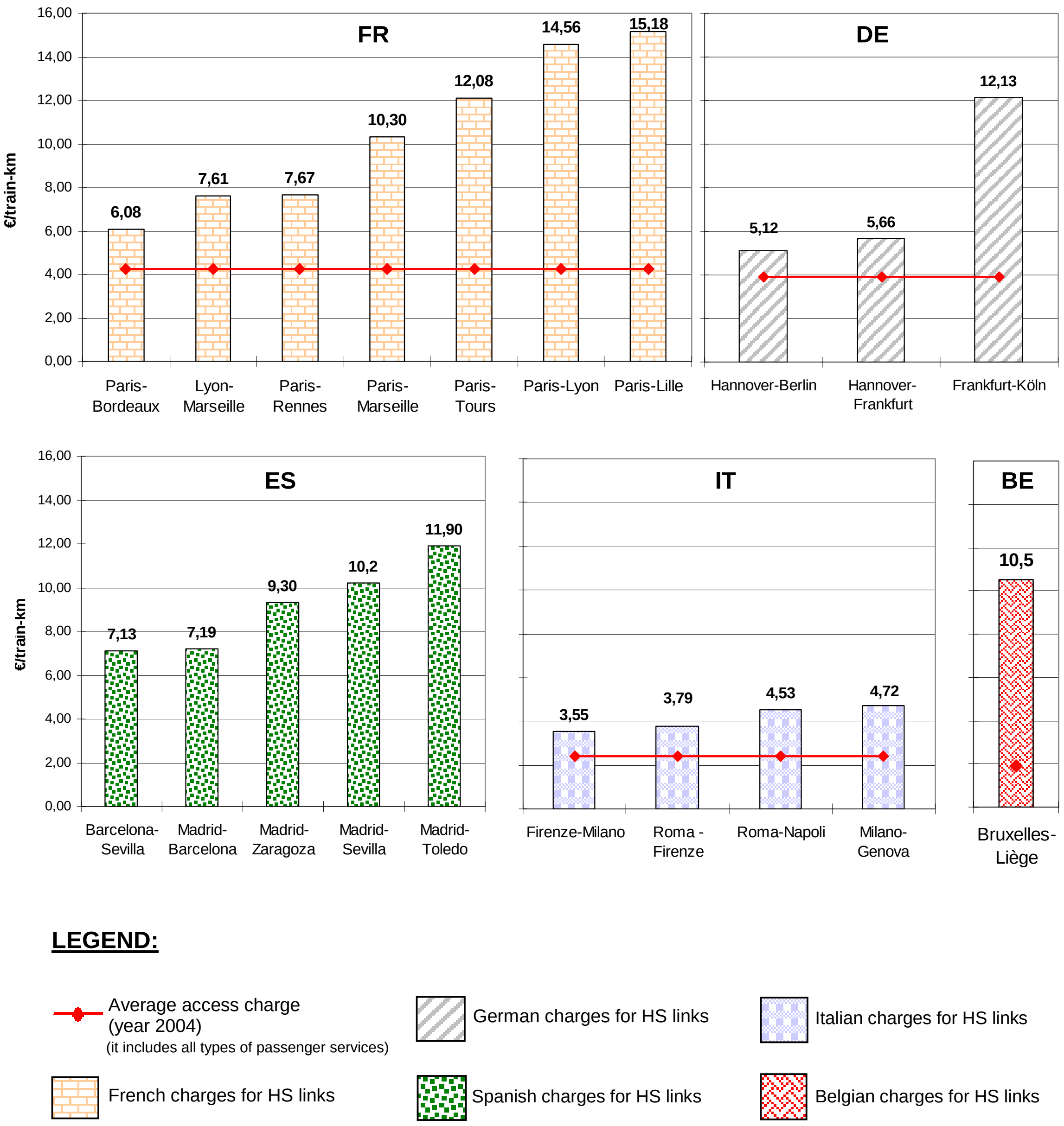
[79] This statement is true even if average access charges correspond to 2004 values, whilst the values for the representative high performance French, German, Spanish, Italian and Belgian railway links correspond to 2005-2006 values.

FIGURE 4.10 COMPARISON BETWEEN RAILWAY CHARGES IN REPRESENTATIVE HIGH SPEED FRENCH, GERMAN, ITALIAN, SPANISH AND BELGIAN RAILWAY LINKS (FOR 2005-2006) AND THE AVERAGE ACCESS CHARGE (FOR 2004) PUBLISHED BY CEMT (2005) FOR THE AFOREMENTIONED COUNTRIES. Source: Based on Sánchez-Borràs et al. (2008a)



Remark: France, Italy and Spain apply a two-part tariff structure. The French and the Italian Network Statements present their fixed charges (access right) as unit prices to be applied to each single running. In contrast to RFF and RFI, Adif publishes fixed charges for the access to infrastructure as a lump sum. In order to allocate the fixed charge to each one of the links considered, the value given by the Spanish IM was divided by the traffic (expressed in train-km) registered by Renfe for the year 2005 and the value obtained used as unit value of the access tariff.

TABLE 4.9 CONCEPTS TO WHICH MARK UPS SEEM TO BE APPLIED
Source: Sánchez-Borràs et al (2009).

Country	Concepts to which mark ups seem to be applied		
	Wear and tear	Investment costs	Commercial position
France	- Charge for access to electric traction equipment	- Access & reservation charges (R.ch.: 61% of total infrastructure fees in 2005)	- Congestion charges according to time period and geographical situation
Spain	- Capacity reservation tariff (fixed maintenance, operation, management costs)	- Operating tariff: mark up for construction costs - Traffic tariff: only for HSL	- Capacity reservation (time period, top speed) - Operating tariff: ability to pay for faster trains - Traffic tariff (HSL): seat-km offered, peak hours
Germany	- Usage based component (speed differentiation)		- Usage-based component: market driven (route availability, train-path/km) - Product factor: WTP - Utilisation factor: mark up for congestion
Italy	- $R_{km/min}$: cost of the use of infrastructure - $P_{wear\&tear}$	NO	- P_{speed}: congestion - $P_{density}$: traffic demand, time periods - Nodes (time, period): mark up for congestion
Belgium	- C (Admissible weight on track)		- Category of running priority (Pt) - Category of line: congestion costs - H (time period): ability to pay - Train path facility charge: ability to pay, congestion

Remarks: The separation between mark ups applied to investment costs and commercial position is not always very clear, since very often one aspect merges with the other one in terms of ability to pay.

- *On the other hand, Ramsey-Boiteux pricing is broadly applied in those countries charging mark ups to social marginal cost, differentiating by broad category of passenger train, location and time of day, although with different criteria in each country*: Infrastructure charges for high speed lines seem to be a mix of recovery of the capital cost with a mark up on what the market can bear.

- *Finally, mark ups applied to high speed lines seem to be higher than the optimal values presented in section 1.4.2.3*, except for the Italian case, the only one not aiming at recovering investment costs: Calculations published by Sánchez-Borràs et al (2008b) for the year 2006 and for a train supposed to leave at 8 a.m. from the origin point and heading for the destination point (for those pricing systems considering the timetable period for the calculation of infrastructure charges) and without taking into consideration intermediate stops in order to ease the calculations, result in infrastructure charges above 10 €/train-km for the main national links of the countries analysed with the exception of the Italian link (Paris-Lyons: 14,6 €/train-km; Madrid-Seville: 10,2 €/train-km; Frankfurt-Cologne: 12,1 €/train-km; Brussels-Liège: 10,5 €/train-km; Rome-Florence: 3,8 €/train-km).

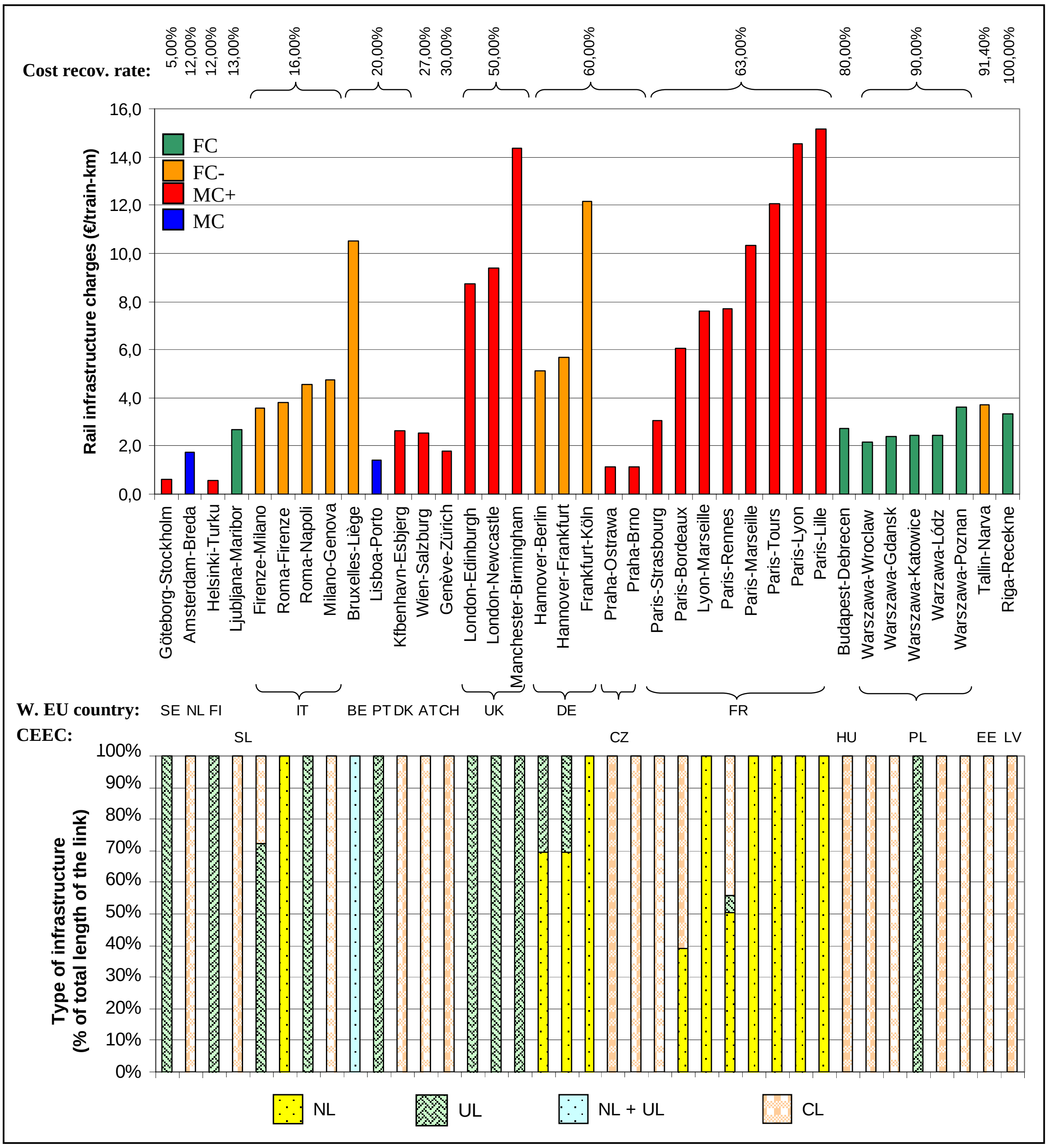
4.4. POSSIBLE SIMILARITIES IN THE APPLICATION OF MARK UPS ABOVE MARGINAL COST FOR HIGH SPEED SERVICES

Previous works gave average values for infrastructure charges in different European countries ranging from less than 0,5 €/train-km to up to 4 €/train-km in the case of passenger services (CEMT, 2005). However, others (Crozet, 2004b) said that values for particular time periods or specific lines (such as high speed lines) might give rise to much higher levels. Sections 4.2 and 4.3 have shown that the charging systems applied on the networks with new high speed lines in operation involve important mark ups above the marginal cost of wear and tear, giving rise to much higher charging values as foreseen by Crozet (2004b). The present section intends to analyse whether some similarities in the application of mark ups above marginal cost for HSL can be detected in quantitative terms.

In the preceding section it has been shown that mark ups seem to be based on wear and tear costs and to reflect investment costs and the commercial position. Therefore, in the next sections, the influence that the consideration of wear and tear costs, investment costs and the commercial position of the market by pricing systems can have on the value of charges for high speed lines will be analysed.

With regard to the reflection of investment costs and the commercial position by charging systems, construction costs are bound up with the type of railway infrastructure (conventional, upgraded, new –the latter corresponding to high speed lines–), whilst the position of the market is to a great extent determined by the commercial speed and the travel time. **Figure 4.11** (which presents the infrastructure charges values for the national links selected in chapter 3, for which the charging philosophy and the cost recovery rate[80] is known[81]) enables making the following points:

FIGURE 4.11 RAIL INFRASTRUCTURE CHARGES SORTED BY INCREASING ORDER OF COST RECOVERY RATE, DISTINGUISHING BY CHARGING PHILOSOPHY, COUNTRY CATEGORY (EASTERN/WESTERN EUROPEAN COUNTRY) AND TYPE OF INFRASTRUCTURE



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[80] The cost recovery rates correspond to those published by CEMT (2005). Values correspond to the cost recovery of the whole railway network (and not the specific link analysed) valid in 2004-2005.

[81] Spain is not included in the graphic because data on the cost recovery rate is not available.

- For links within a given country, higher construction costs (better infrastructure characteristics) lead to higher infrastructure charges (in countries where infrastructure charges are supposed to cover part of the investment costs): It is well known that new lines (or high speed lines) are considerably more expensive than conventional lines, because of the higher technical requirements necessary for reaching high speeds. Since State budgets are limited, it is to be expected that charges try to recover at least part of the investment costs of these high speed lines.

- The great differences in the level of charges for new high speed lines in the French links seem to be tied to the market’s ability to pay (commercial speed and travel time).

Hence, the search for similarities in the application of mark ups reflecting investment costs and the commercial position focuses on the analysis of the existence of correlations between the level of infrastructure charges and three parameters: the type of railway infrastructure, the commercial speed and the travel time.

4.4.1. Influence that the consideration of wear and tear cost by pricing systems may have on the value of charges for high speed lines. Mark ups based on wear and tear costs

In **table 1.12**, the results of empirical studies on marginal rail infrastructure costs have been presented. The only results distinguishing marginal costs by type of line (or service) refer to the French network. For this network, the results published by Crozet (2007) from data from Gaudry and Quinet (2003) show that marginal costs amount to 2,1-2,4 €/train-km for high speed services, 2,9-3,1 €/train-km for suburban services (IdF[82] services), and 2,0-3,6 €/train-km for intercity services (TER services). Gaudry and Quinet (2003) present these differences in marginal costs among services in terms of relative marginal costs, as summarised in **table 4.10**.

According to Quinet, the reasons that could justify why marginal costs of wear and tear for passenger trains are higher than those for freight trains and why those for high speed trains are lower than those for suburban and intercity services are the following ones:

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[82] IdF stands for Île-de-France.

TABLE 4.10 RELATIVE MARGINAL COSTS AMONG EACH SERVICE AND AMONG TONS OF THESE SERVICES IN FRANCE
Source: Gaudry and Quinet (2003)

Type of service	Equivalence among types of services	Equivalence among tonnes of types of services
High speed services	1,00	1,00
TER services	2,22	5,58
IdF services	1,42	1,94
Freight services	0,81	0,41

- A *shortage of funds for maintenance* may induce to favouring the most circulated tracks (in terms of prevention and renewals) and result in an increase of the marginal cost of the other ones, which are more subject to curative maintenance.

- Although the damages of the trains have an influence on maintenance costs, those costs also depend on the *quality level objective*: As affirmed by Ubalde (2004), maintenance activities do not only depend on the level of wear and tear but also, among other aspects, on the requirements in terms of line performance. Indeed, segments with a large proportion of freight trains do not require a high level of quality while segments with a large proportion of passenger trains require a high quality level. **Table 4.11** presents the corrective intervention thresholds used in Spain by the former Renfe for identifying specific buckling of rail and track gauge defects, which are shown to be higher in new lines (high speed lines), since the higher the speed allowed in a segment of a line, the more restrictive the corrective intervention threshold. These more restrictive corrective intervention thresholds are intended to ensure the accomplishment of the higher requirements in terms of line performance.

- Maintenance costs are influenced by the definition of *track possessions*: Short track possession with a large number of trains (this would be the case of tracks with regional trains) induces more expensive maintenance costs (except when the maintenance is performed during nocturnal periods, which is the case of high speed trains and some suburban tracks in France).

Therefore, the fact that high speed lines are built to a high standard and because they are maintained at night, would justify why the marginal wear and tear cost is lower for those lines compared to conventional lines even though they have to be maintained to higher standards than other passenger lines.

TABLE 4.11 CORRECTIVE INTERVENTION THRESHOLDS WHEN IDENTIFYING SPECIFIC WARPING OF TRACK AND TRACK GAUGE DEFECTS
Source : López-Pita et al (2002) from Renfe

Speeds (km/h)	Warping of track in:			Open track gauge (mm)	Closed track gauge (mm)
	3m base (mm)	5 m base (mm)	9 m base (mm)		
v ≤ 80	±5	±2,8	±2,3	+15	-5
80 < v ≤ 120	±4	±2,3	±1,8	+10	-5
120 < v ≤ 160	±3	±1,7	±1,4	+10	-4
160 < v ≤ 200	±2,5	±1,4	±1,2	+8	-3
200 < v ≤ 240	±2,2	±1,1	±0,9	+8	-3
240 < v ≤ 280	±2,0	±0,9	±0,7	+7	-2
280 < v ≤ 320	±1,8	±0,7	±0,5	+7	-2
320 < v	±1,7	±0,6	±0,4	+6	-1

According to these results, the level of rail infrastructure charges that are supposed to reflect the marginal wear and tear cost should be lower for high speed lines than for conventional lines if the charges were really set to solely cover the marginal wear and tear cost. However, this is not the case. As **table 4.12** shows, in the rail pricing systems of those networks with high speed lines in operation, charges meant to reflect the marginal wear and tear cost are generally highest for high speed lines. These results could be showing that current rail charging systems apply mark ups based on marginal costs.

TABLE 4.12 CHARGES SUPPOSED TO REFLECT THE MARGINAL WEAR AND TEAR COST AND THEIR VALUE
Source: Own from the corresponding network statements

Country	Charge supposed to reflect the MC of wear and tear	Value (comparison HSL with conventional lines)
France	Charge for access to electric traction equipment (€/electric train-km)	HS national trains > other trains
Spain	Capacity reservation tariff (€/train-km reserved)	New HSL > rest of lines
Germany	Usage-based component	Long distance lines Fplus and F1 > rest of lines
Italy	$R_{km/min}$ (cost of the use of infrastr.) $P_{wear\&tear}$	Higher for higher speeds, higher weight and more pantographs
Belgium	C (admissible weight on track)	Higher for higher weight

The reason that could justify the application of mark ups based on marginal costs of wear and tear is the fact that lower marginal costs of wear and tear for high speed lines are the result of dedicating more funds for maintenance to high speed lines (than to other types of lines) in order to keep the high quality level objective. Hence, the mark ups based on marginal costs of wear and tear would be aimed at recovering part of the higher maintenance expenses for high speed lines that allow those lower levels of marginal costs of wear and tear.

4.4.2. Influence that the consideration of investment costs by pricing systems may have on the value of charges for high speed lines. Mark ups reflecting investment costs

Railway projects have always involved great investment costs. Nevertheless, the construction of new lines (high speed lines) and upgraded lines (high performance lines) has raised them to a greater level. This is a direct consequence of the more precise and restrictive track geometry (for instance in terms of curve radius and cant), as well as the special safety facilities (see annex A1), required to allow maximum speeds in commercial runs up to 250 km/h and 300-350 km/h.

While conventional lines' capital costs are mainly sunk, some States have decided to cover part of new lines investment costs through infrastructure charges. The recovery rate of these costs varies from country to country, as does the construction cost from one high speed line to another (see **table 4.13**). Engineering aspects such as the use of ballast track or slab track, the presence of viaducts, tunnels or other civil works are in the origin of these differences in cost.

TABLE 4.13 ORDER OF MAGNITUDE OF CONSTRUCTION COSTS OF NEW LINES AND UPGRADED LINES (2004 costs)
Source: Own from CENIT (2004) and other sources

Type of line	Line	Construction cost (10^6 €/km)
New line	DE: Köln – Frankfurt (slab track)	26,0
	ES: Madrid – Lleida	10,0
	FR: Valence – Marseille	17,7$^{(1)}$
	BE: Bruxelles – French border	15,7
	UK: London – Folkestone (first section)	37,0
Upgraded line		Very variable

Remarks:

(1) It includes the renewal cost of one station and the cost of three new stations.

Therefore, the recovery of these costs through infrastructure charges can be expected to bring about differences in the amount of infrastructure charges for European high speed or high performance links. The next paragraphs are devoted to analyse the influence that the consideration of investment costs by pricing systems can have on the value of charges for high speed and upgraded lines.

In order to analyse if a correlation can be established between the charge to be paid by a RU offering a high performance passenger service (on the European high speed network) and the type of infrastructure, national links have been considered as a first step. The reason for excluding international links in this first stage of the analysis is to avoid some "interferences" in the results, which could come from the application of different charging systems within a given link.

Those national links have been defined in detail and classified according to the characteristics of their infrastructure into four groups:

- *100% (in length) conventional lines*, that is, lines where the infrastructure can be labelled as conventional over the whole length.

- *100% upgraded lines*, i.e. lines where the infrastructure has been upgraded over the whole length.

- *100% new lines*, that is, lines where the infrastructure has been recently built from scratch over their whole length in order to allow high speed runs.

- *Lines where the type of infrastructure is not homogeneous*, i.e. different combinations of infrastructure constitute the line (combination of new line and upgraded line; new line and conventional line; upgraded line and conventional line; new line, upgraded line and conventional line).

Figure 4.12 shows the value of the charge for those national links, grouped into Eastern and Western countries links and sorted by increasing order[83]. If we do not consider links affected by pricing systems that do not cover investment costs, different general tendencies can be observed:

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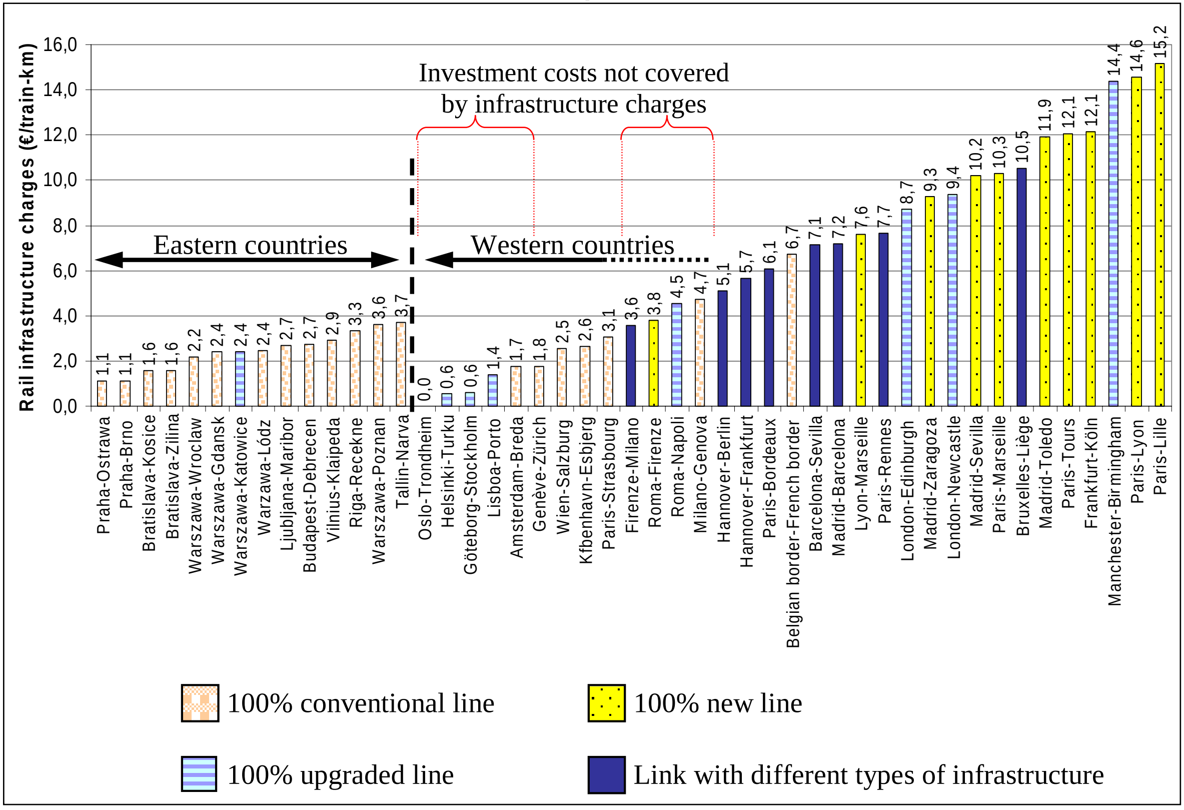
[83] The values for Estonia, Hungary and Latvia were obtained from CEMT (2005), since the corresponding network statements were not available for the year 2006 or were only published in the official language of the corresponding country. Therefore, the values presented for these countries correspond to average infrastructure charges for passenger trains.

FIGURE 4.12 RAILWAY CHARGES FOR EUROPEAN NATIONAL PASSENGER SERVICES, DISTINGUISHING BY TYPE OF INFRASTRUCTURE (NEW LINES, UPGRADED LINES, CONVENTIONAL LINES)



- *In conventional lines the amount of the infrastructure charge tends to have lower values*: The amount of the infrastructure charge to be paid by RUs running on conventional lines ranges from 1,8 to 6,7 €/train-km for Western links and from 1,1 to 3,7 €/train-km for Eastern links. The highest value (6,7 €/train-km) is approximately half the value of the most expensive link analysed, which corresponds to a new line.

- *In new lines the amount of the infrastructure charge tends to have higher values*: The amount of the infrastructure charges to be paid by RU running on new lines ranges from 7,6 to 15,2 €/train-km.

- *The amount of infrastructure charges for the use of upgraded lines presents a great variability*: For this type of lines, infrastructure charges range from 0,6 to 14,4 €/train-km. The analysis of the length and the commercial speed of the links belonging to this category does not provide a satisfactory explanation for the aforementioned variability (see **table 4.14**). In this case, the analysis of the pricing principle and the cost recovery rate is fundamental to understand the differences.

As an example, in the British links, the pricing principle (MC+) and the high cost recovery rate (50%), which is considerably higher than those of the rest of Western Europe according to ECMT (2005), may explain the high value of charges compared to the ones registered by the Finish and the Swedish pricing systems, which cover 12% and 5%, respectively, of the total infrastructure costs.

- *The existence of a segment of line with new or upgraded infrastructure considerably increases the amount of the charge to be paid by a train running on such a link*: The amount of the infrastructure charge to be paid by RU running on lines where the type of infrastructure is not homogeneous ranges from 3,6 to 10,5 €/train-km. These values are in some cases as high as the values in new lines. These differences could be due to the percentage in length of new or upgraded lines in the link. Two other country-specific reasons could explain these results: on the one hand, in Belgium, high values are as a result of high charges for the use of stations (they represent 70% of total infrastructure charges for the Brussels – Liège link); on the other hand, in Germany and France the reason could be the high cost recovery rates.

- *Eastern countries seem to follow the same pattern as Western countries with regard to the correlation between the amount of charges and the type of infrastructure*: Nevertheless, attention has to be drawn to the fact that even if Poland affirms to partly cover investment costs through infrastructure charges, their cost recovery for passenger services is not reflected in the amount of charges. Therefore, although Eastern countries are said to have high cost recovery rates, it may be that they are reached through higher contributions by freight services, either by means of cross-subsidies or through the application of different pricing systems according to the traffic (for instance, in some cases passenger services are only charged marginal costs, whilst freight services are charged all fixed costs).

TABLE 4.14 CHARACTERISTICS OF 100% UPGRADED LINES

Link	Rail infrastructure charges (€/train-km)	Distance (km)	Commercial speed (km/h)
Helsinki-Turku	0,6	200	103
Lisboa-Porto	1,4	337	112
Roma-Napoli	4,5	232	123
London-Edinburgh	8,7	553	122
London-Newcastle	9,4	432	146
Manchester-Birmingham	14,4	123	79

In order to see to what extent these tendencies are observed in the whole of high speed network, that is in both national and international links, in **figure 4.13** rail infrastructure charges for approximately 100 links that constitute the high performance European railway network have been sorted by increasing order (top-down) and at the same time, in **figure 4.14** they have also been broken down by type of infrastructure (expressed in percentage of the total length of the link).

These figures confirm that infrastructure charges for links with new lines or upgraded lines are among the most expensive ones. Indeed, as it was to be expected from the analysis of the different European pricing systems, there is a correlation between rail infrastructure charges and the type of infrastructure, according to which the percentage in length of new line in a link seems to be directly proportional to the amount of charge to be paid by a passenger train running through a link of the European high speed network, i.e. the longer the length of the link with new line, the higher the amount of infrastructure charge.

Therefore it can be concluded that the consideration of investment costs by pricing systems can have an important influence on the value of charges for high speed lines. Indeed, they can result in infrastructure charges ranging from less than 1 €/train-km to more than 48 €/train-km. Nevertheless, these differences could also be explained by the commercial position of the different links, as may be inferred by the wide range of values among new lines within a given country, particularly visible in French high speed lines. This aspect will be dealt with in section 4.4.3.

The results presented in this section are of great interest, since the studies published until now (for instance the one published by the European Conference of Ministers of Transport published in 2005 –ECMT, 2005–) had neither related charges to infrastructure characteristics nor studied in detail charges for high performance passenger services.

FIGURE 4.13 RAIL INFRASTRUCTURE CHARGES FOR PASSENGER RAILWAY SERVICES RUNNING ON THE HIGH SPEED EUROPEAN NETWORK IN 2006

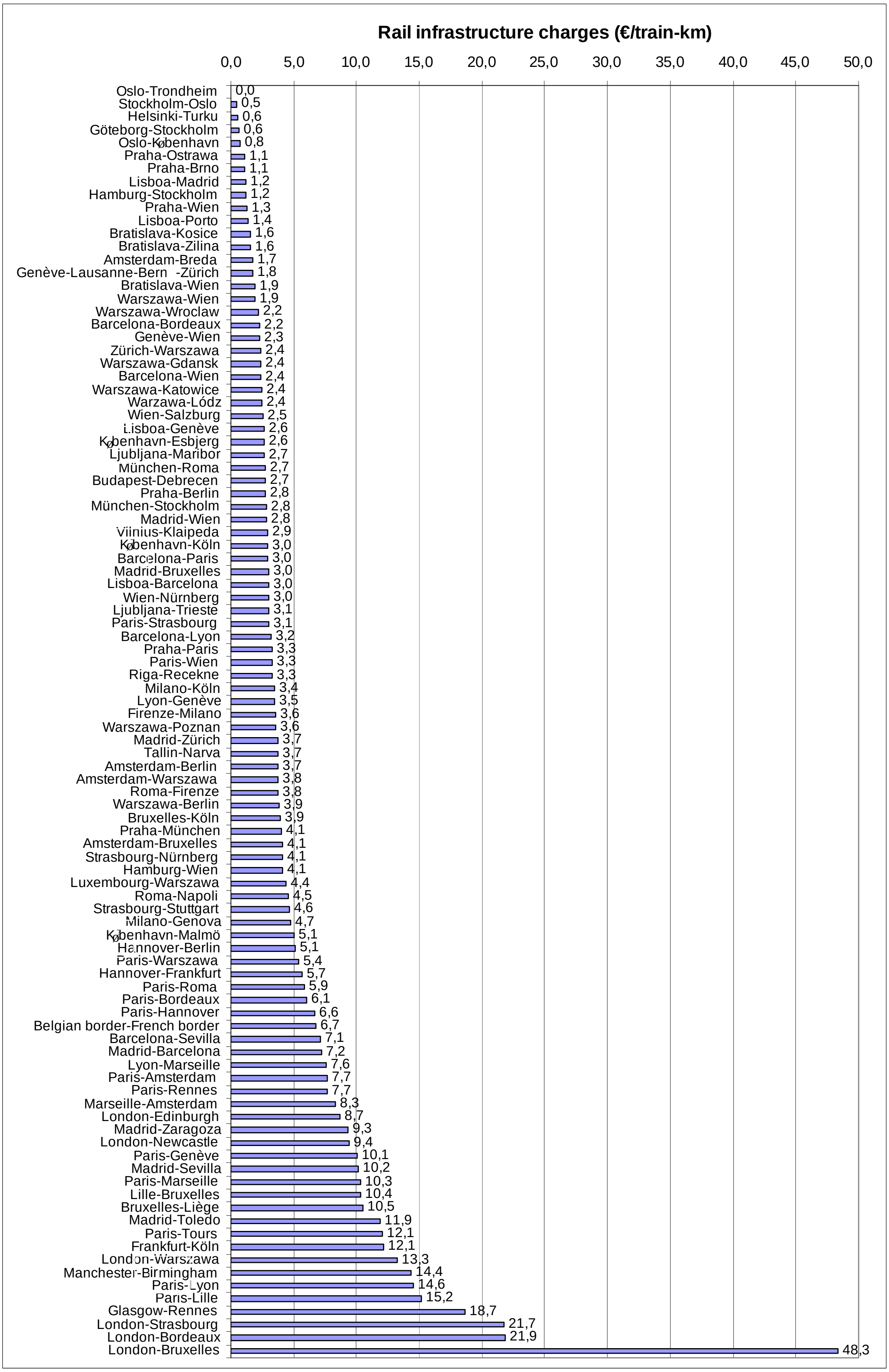
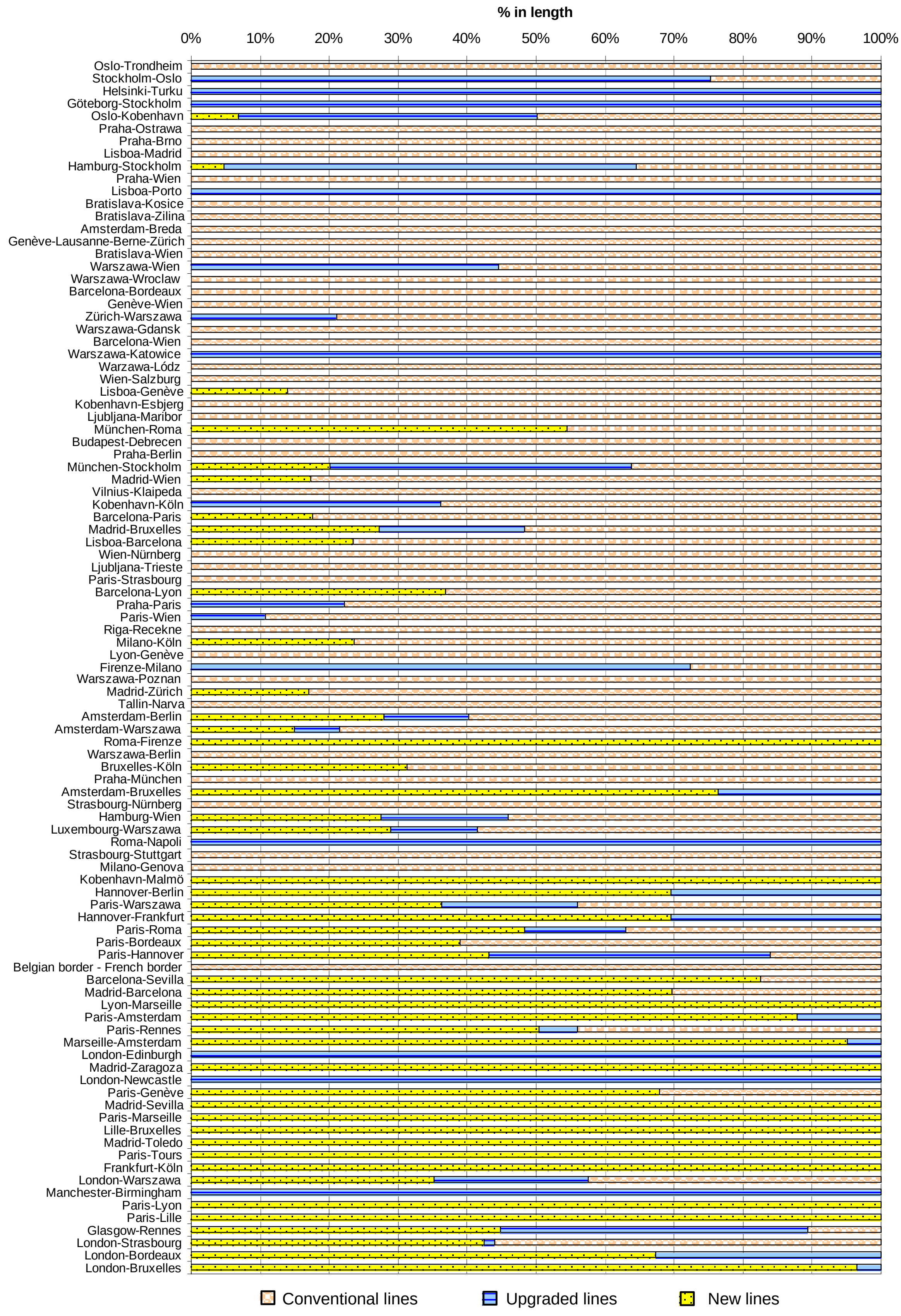


FIGURE 4.14 RAILWAY CHARGES FOR EUROPEAN HIGH PERFORMANCE PASSENGER SERVICES, SORTED BY INCREASING ORDER OF THE CHARGE AND DISTINGUISHING BY TYPE OF INFRASTRUCTURE



4.4.3. Influence that the consideration of the market's commercial position by pricing systems may have on the value of charges for high speed lines. Mark ups reflecting commercial position

The commercial position of a transport mode in a particular link depends on several factors, such as the total travel time, the frequency and the commercial speed. The first factor is closely related to the total length of the link and the line performances, which will be determinant in the definition of the maximum running speed allowed on it and, therefore, the commercial speed.

High speed services are characterised by reduced travel times compared to conventional passenger railway services, thanks to the higher maximum and commercial speeds achieved on new lines. These reduced travel times are especially valued by passengers. Indeed, according to a study carried out in 1993 on the demand requirements depending on the trip purpose, rapidity scores 12 out of 12 for business trips (12 being the highest score) and 9 out of 12 for private trips (López-Pita, 1998). Therefore, users are prepared to pay more for faster trains, i.e. passengers' ability to pay is extremely bound up with commercial speeds.

Railway operators have taken advantage of this fact increasing their ticket fares and thus earning more revenues from the links where the market willingness to pay is higher. Infrastructure managers seem to have applied the same strategy through their charging systems. As **table 4.9** shows, in countries with high speed lines in operation, charges seem to be set taking into consideration the commercial position of high speed railways.

This section analyses the influence that the consideration of the commercial position of the market by pricing systems can have on the value of charges for high speed lines. For this analysis, the commercial speed has been used as an indicator of the line's performance and, therefore, of the commercial position.

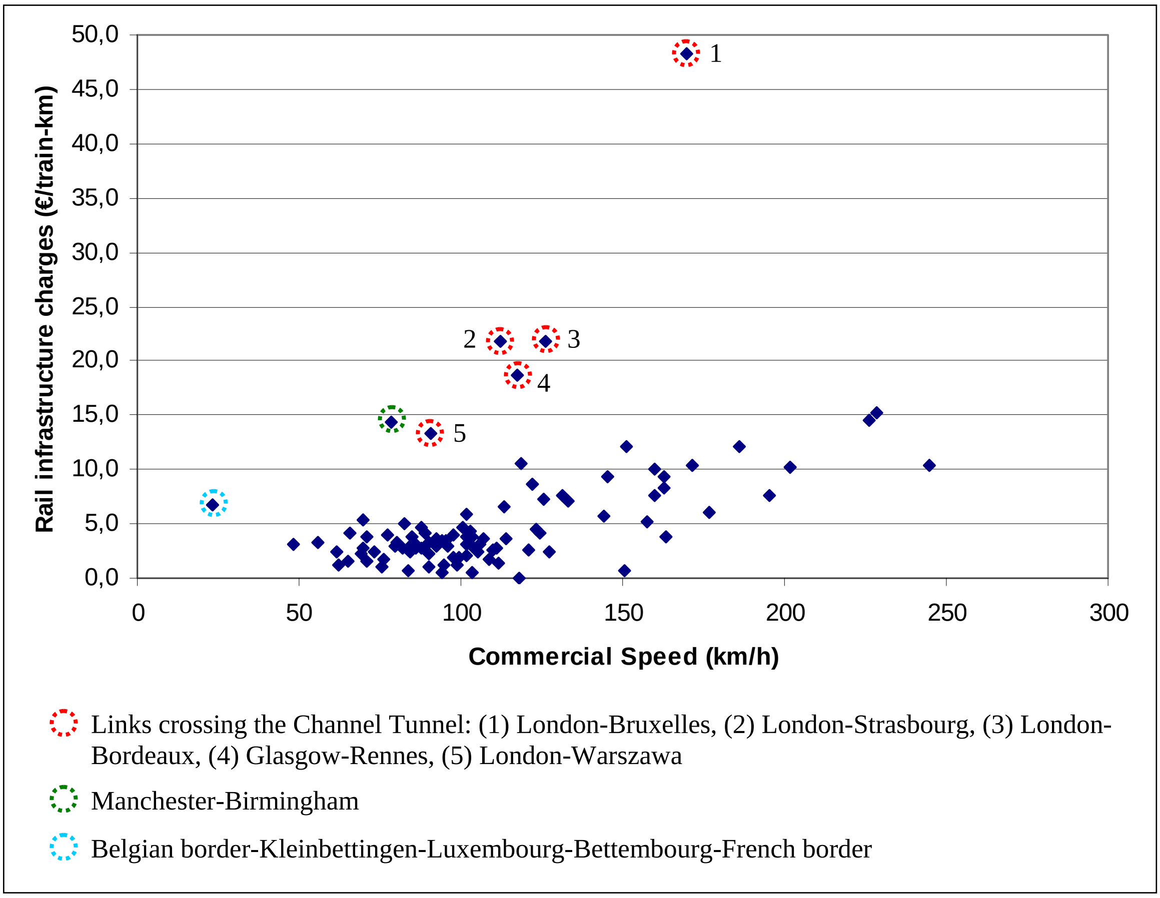
In **figure 4.15,** for the set of 100 links selected in chapter 3, the value of the rail infrastructure charges has been presented as dependent variable and the commercial speed as explanatory variable. If the links surrounded by a circle are not taken into consideration, one can distinguish a correlation between rail infrastructure charges and commercial speed, which seems to confirm the existence of a correlation between high charges and infrastructure allowing high commercial speeds.

The links surrounded by a circle correspond to five links crossing the Channel Tunnel (namely, London-Brussels, London-Bordeaux, London-Strasbourg, Glasgow-Rennes and London-Warsaw) and the links Manchester-Birmingham and the one crossing

Luxembourg from the Belgian border to the French border (via Kleinbettingen, Luxembourg and Bettembourg).

With regard to the Channel Tunnel, which links Folkestone in Kent to Coquelles in Pas-de-Calais, it is important to mention that it corresponds to the longest undersea tunnel in the world, with a 38 km long section under the sea, bored at an average 40 m below the sea bed. Its construction costs amount 14.680,12 M€ (293,60 M€/km[84]), including financing by shareholder funds and bank loans (Eurotunnel, 2006). Since it works with private financing, infrastructure charges for crossing the Channel Tunnel have been conceived to guarantee cost recovery. This explains the higher infrastructure values compared to the ones in the rest of the links. Given the specificity of the charging system of the Channel Tunnel, the links crossing this big civil work will not be taken into account in this part of the analysis.

FIGURE 4.15 RAIL INFRASTRUCTURE CHARGES (IN €/TRAIN-KM) CONTINGENT ON COMMERCIAL SPEED (IN KM/H)



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[84] Construction costs for new lines range approximately between 10 M€/km (e.g. Madrid-Lleida link, build with ballasted track) and 40 MEUR/km (e.g. Nuremberg-Ingolstadt link, built with slab track), according to CENIT (2004) data.

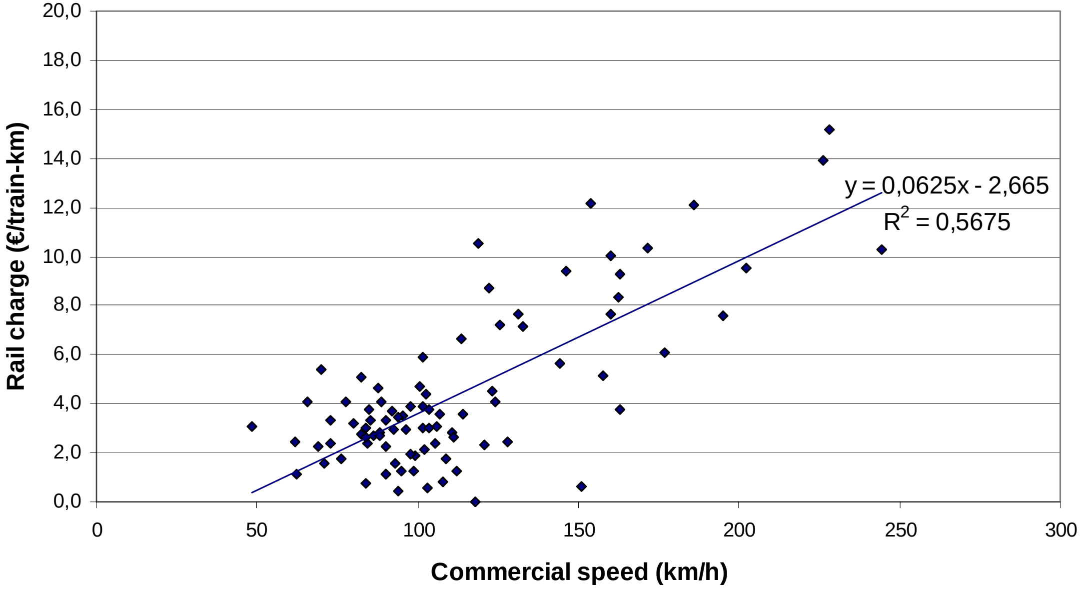
Concerning the link crossing Luxembourg from the Belgian border to the French border (via Kleinbettingen, Luxembourg and Bettembourg), there is no direct train linking the origin and the destination points. Therefore, the total travel time increases significantly and results in a very low commercial speed (23 km/h). Since such a low value for commercial speeds is not representative of the ensemble of links, this link will be eliminated from the analysis of the correlation between rail infrastructure charges and the commercial speed.

Finally, the Manchester-Birmingham link will also be eliminated from this analysis, since its values are similar to the ones observed for the links crossing the Channel Tunnel. This is the result of the high fixed charge resulting from the British charging system.

FIGURE 4.16 ECONOMETRIC ANALYSIS USING THE INFRASTRUCTURE CHARGES AS THE DEPENDENT VARIABLE AND THE COMMERCIAL SPEED AS EXPLANATORY VARIABLE.

$$y = \beta x + \alpha$$

Dependent variable: y = rail infrastructure charges (in €/train-km)
Explanatory variable: x = commercial speed (in km/h)
Regression coefficient: β = 0,0625
95% confidential interval for β: [CI] = [0,051;0,074]

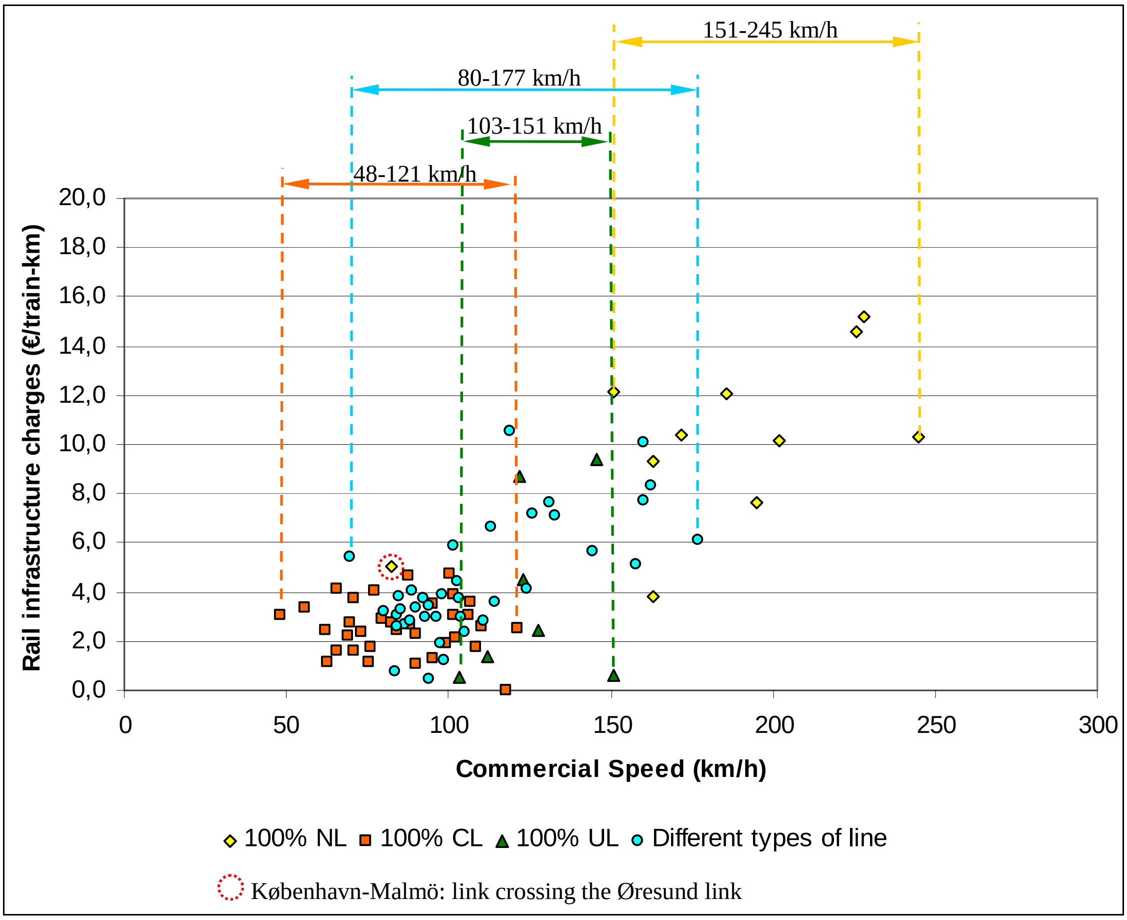


Remark: Links crossing the Channel Tunnel, the Manchester-Birmingham link and the link crossing Luxembourg from the Belgian border to the French border via Kleinbettingen, Luxembourg and Bettembourg, not considered.

In **figure 4.16** the results of the econometric analysis carried out without taking into consideration the links mentioned in the preceding paragraphs are presented. In this econometric analysis, infrastructure charges are the dependent variable and the commercial speed is the explanatory variable. According to the simple linear regression carried out, the regression coefficient for the variable rail infrastructure charge is 0,0625 (95% confidential interval [CI]:0,051;0,074). The model was validated with the analysis of the residuals.

The results of the econometric analysis are as expected: there is a strong correlation between high infrastructure charges and infrastructure with high performance (expressed in terms of commercial speed).

FIGURE 4.17 RAIL INFRASTRUCTURE CHARGES (IN €/TRAIN-KM) CONTINGENT ON COMMERCIAL SPEED (IN KM/H), DISTINGUISING BETWEEN LINKS WITH ONLY ONE TYPE OF INFRASTRUCTURE (NEW LINES, UPGRADED LINES OR CONVENTIONAL LINES) AND LINKS WITH DIFFERENT TYPES OF INFRASTRUCTURE



In order to graphically reflect how these commercial speeds are linked to the type of infrastructure, **figure 4.17** was produced. In it, values are grouped into 4 categories (represented by a different coloured polygon in the graphic): (1) 100% conventional links (orange squares), (2) 100% upgraded links (green triangles), (3) 100% new links (yellow rhombus) and (4) non-homogeneous links, e.g. partly upgraded, partly new (blue circles).

Several conclusions can be drawn from **figure 4.17**. On the one hand, for conventional lines, which are the ones offering the lowest commercial speeds currently available in the passenger railway market (48-121 km/h), it is not possible to establish a correlation between infrastructure charges and commercial speed. This result seems to confirm that current rail European pricing systems do not consider the commercial position of the market in their conventional network. In other words, current charging systems do not apply any mark up on the ability to pay of RUs offering conventional passenger services.

On the other hand, **figure 4.17** clearly shows that, contrary to conventional lines, infrastructure charges for new lines are very sensitive to an increase of commercial speed. This would be in line with charging systems considering the commercial position of the market (see **table 4.9**).

In the French case, as it could be expected from **figures 4.10** and **4.11** and from the characterisation of the pricing system presented in section 4.2, the commercial position exerts a strong influence on the value of charges for high speed and high performance services. As stated by Crozet (2004b), in France the charging structure takes sharply into account the abilities to contribute as well as the service quality, with a highly and more and more differentiated charges in time and space. Indeed, for links belonging to a single corridor, as for instance Paris-Lyons, Paris-Marseilles or Lyons-Marseilles, differences in charges exist due to the time differentiation applied by the French rail infrastructure pricing system (see **figure 4.18**). The great differences in charges in the Lyons urban area between the links passing through it and the links departing from it are not only due to time differentiation of charges, but also to the amount due for the use of the station, considered only (according to the assumptions made in chapter 3 but also according to RFF’s Network Statement) in the journeys starting in Lyons.

The consideration of the commercial position in the different countries with high speed lines in operation seems to be closely related to the travel time, as can be observed in **figure 4.19**[85].

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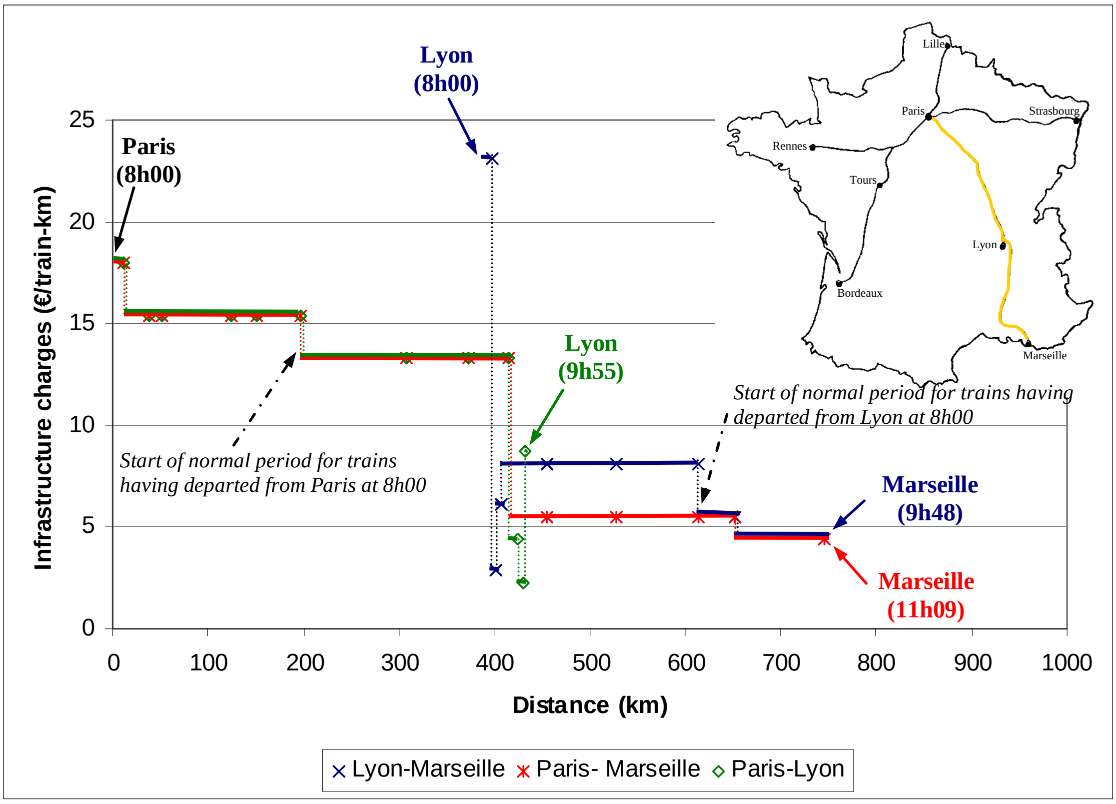
[85] The results presented correspond to infrastructure charges for services departing at 8 a.m. from the origin point (calculation hypotheses presented in chapter 3).

FIGURE 4.18 INFLUENCE OF TIME DIFFERENTIATION ON THE LEVEL OF CHARGES IN THE PARIS-MARSEILLES CORRIDOR FOR RUNS STARTING AT 8 A.M.



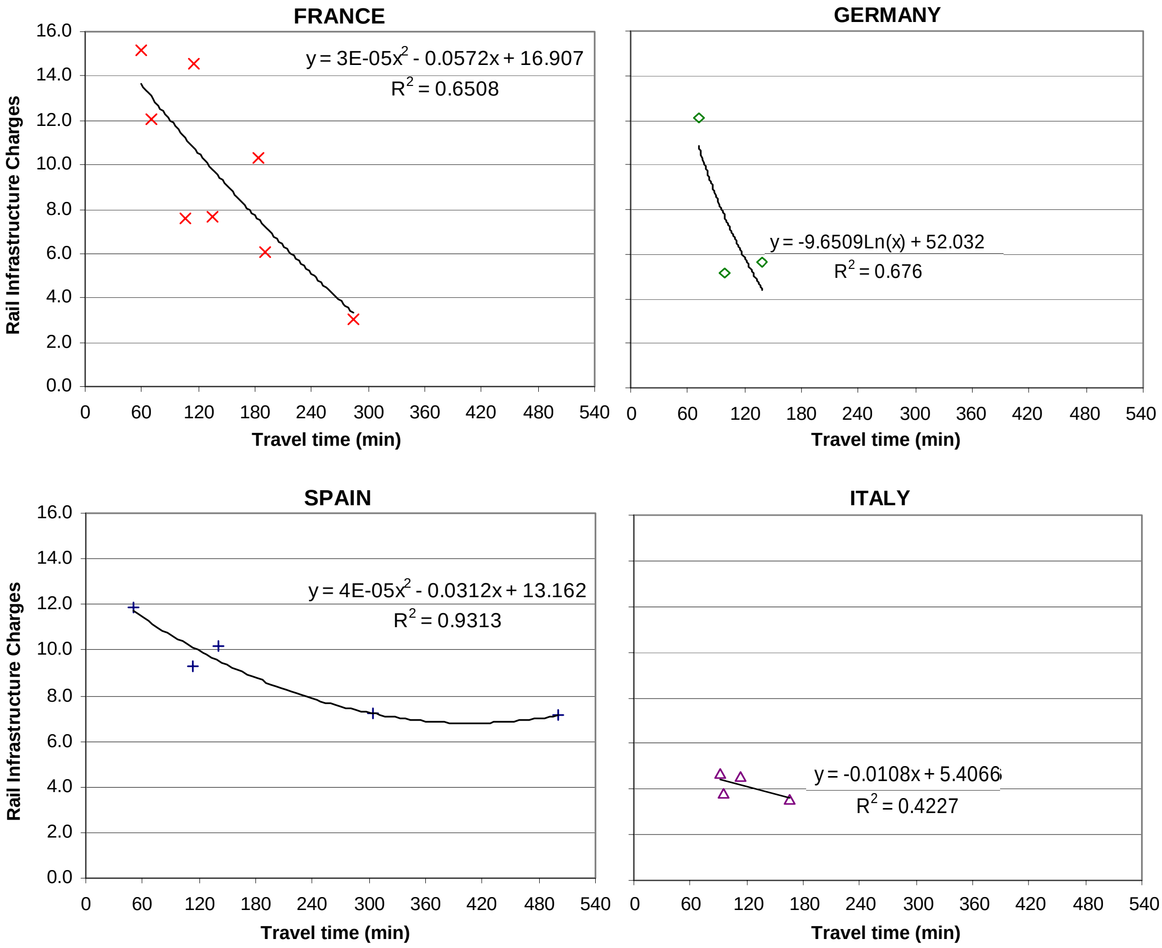
The French charges for high speed services seem to be very sensitive to the travel time (see **figure 4.19)**. Indeed, an increase of the travel time from one hour to two hours can imply differences in charges as high as approximately 7 €/train-km. It is also remarkable that an additional mark up on the ability to pay seems to be in place for the services linking Paris with the two other main French cities: Lyons and Marseilles.

In Spain, where the commercial position of the market is also considered by the pricing system through several tariffs (reservation capacity tariff, operating tariff, traffic tariff, tariff for the station use and transport security fees), the influence of the travel time on the value of charges for high speed lines is lower than in France (see **figure 4.19**). Indeed, an increase of the travel time from one hour to two hours can imply differences in charges of about 2 €/train-km, difference considerably lower than the 7 €/train-km registered in France.

In Germany, the influence of the travel time on the value of charges for high speed services seems to be very close to the one observed in France (there are too few observations available for a proper statistical estimation). However, according to CEMT

(2005), “in Germany charges vary a little bit with the ability to pay, in order to stimulate RUs to use capacities in a rational manner”.

FIGURE 4.19 CORRELATION BETWEEN RAIL INFRASTRUCTURE CHARGES AND THE TRAVEL TIME FOR HIGH SPEED SERVICES IN EUROPE (year 2006)



Remarks: The links analysed are those composing the current European high speed network (new lines and upgraded lines, in some cases combined with some sections built as conventional lines) as well as a few conventional lines which in a near future will be new high speed lines. This explains the higher number of observations in France and Spain, which are the European countries with more kilometres of HSL in service.

In Italy, the consideration of the commercial position by pricing systems seems to have a smaller influence on the value of charges for high speed services than in the countries presented (as for Germany, there are too few observations available for a proper statistical estimation).

For the Belgian pricing system, the influence of the commercial position on the value of charges for high speed lines could not be analysed, since only one link was defined for this country.

The results presented in this section confirm that the consideration of the commercial position of the market by pricing systems can have an important influence on the value of charges for high speed lines. Charges for high speed lines seem to be strongly bound up with the total travel time; indeed, a reduction of a journey from 2 hours to 1 hour implies for instance mark ups of up to 7 €/train-km in France and 2 €/train-km in Spain.

If the potential of high speed trains is further developed in the years to come[86], travel times will be shortened. This could result, in some cases, in a higher ability to pay. Furthermore, the expected internalisation of external costs in all transport modes could further increase the commercial position of high speed railways. With those assumptions and if the current correlation between infrastructure charges and commercial speeds is maintained in the years to come, an increase in the value of infrastructure charges for new lines is to be expected.

4.5. COMMENTS ON THE VALUE OF RAIL INFRASTRUCTURE CHARGES FOR THE USE OF RAIL INFRASTRUCTURE IN THE EUROPEAN HIGH SPEED NETWORK

While, as a rule, urban or rural transit services lose money and have to be subsidised, intercity trains and especially HSR are able to generate cash surpluses. In this chapter it has been analysed how the pricing systems implemented in the European countries with HSL have taken into consideration the ability and willingness of intercity and HSL operators to make a financial contribution towards part of the cost, materialised in the level of charges (or mark ups) for the use of infrastructure.

The results obtained prove that even if current European charging systems for HSL differ considerably, there is a similarity between them in terms of the implementation of mark ups. On the one hand, the unit values charged to high speed services appear to be well above marginal costs and even over the optimal mark up for high speed lines calculated in chapter 1. On the other hand, mark ups seem to be introduced by means of three different common concepts, namely mark ups based on wear and tear costs, mark ups to recover

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[86] This possibility is feasible, since trial runs on the *LGV Est* linking Paris to Strasbourg in France have attained maximal speeds of 574 km/h. Currently the maximal speed in commercial journeys is 350 km/h.

part of the investment costs and mark ups set at a level that the market can bear, taking into consideration the commercial position of HSR.

The data available does not allow to know how much of the mark ups relate to what costs. However, the results suggest that where pricing systems are meant to partly cover investment costs, the higher the share of high performance infrastructure in a given link, the higher the level of charges per kilometre. In addition, this chapter has proven that mark ups that take the commercial position into account are only applied to new and upgraded infrastructure.

With respect to international traffic, mark ups are typically just de sum of the mark ups applied to that category of traffic in each country through which it passes. Thus the mark up for the whole journey is not considered, or worse still, if it is considered then each IM may try to earn a surplus from such traffic regardless of what the other IMs are doing. In annex A9, the consequences of the application of the current charging philosophies and mark ups in international links are analysed in detail. This annex shows that the current charging systems involve some barriers to international services, derived from the fact that the combination of linear tariffs and two-part tariffs result in an economic border, whilst the different charging philosophies and cost recovery rates along an international link provokes imbalances between governments in terms of financing of an international link. Therefore, where charges exceed short-run marginal social cost, charges for international traffic really need to be negotiated between the IMs concerned and set at a corridor level in the light of the competitive position of rail in the corridor as a whole (Sánchez-Borràs et al, 2008c).

CHAPTER 5

ANALYSIS OF THE LINK BETWEEN RAIL CHARGES FOR THE USE OF INFRASTRUCTURE AND RAIL REVENUES FROM TICKET SALES

5.1. INTEREST OF ANALYSING THE LINK EXISTING BETWEEN RAIL INFRASTRUCTURE CHARGES AND REVENUES FROM TICKET SALES

The results presented in chapter 4 have confirmed that European pricing systems apply important mark ups above marginal costs to high speed services running on new and upgraded lines (high speed and high performance lines). At the same time, the amount of charges resulting from those mark ups on investment costs and according to the commercial position has been quantified. The present chapter is devoted to analyse the link between rail charges for the use of infrastructure and RU's rail revenues from the ticket sales[87], as a previous stage to calculating (in chapter 6) how the important mark ups charged above marginal costs to HS operators could be affecting the traffic level[88].

The link between rail infrastructure charges and rail revenues from ticket sales has been calculated for the high speed network links defined in chapter 3. Furthermore, the values obtained (see annex A6) have been analysed in terms of their correlation with the type of infrastructure (bound up with investment costs and consequently with mark ups intended to recover investment costs) and the commercial position in the market. This analysis aims at characterising the influence that the application of mark ups intended to recover investment costs and to reflect the commercial position of a link may have on the charges-to-revenues ratio. Finally, the charges-to-revenues ratios and the margins over infrastructure charges[89] for railways have been compared to those for airways offering services on the same links. These results constitute a first approach to the characterisation

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[87] As presented in chapter 3, revenues are calculated as the fare F times the capacity C of the vehicle and times the load factor L ($Q = C \cdot L$ being the traffic volume per train –number of passengers per train–).

[88] According to the assumptions made in chapter 3, a variation in the level of infrastructure charges causes a variation in traffic levels equivalent to $\frac{\Delta Q}{Q} = \frac{\varepsilon}{1+\varepsilon} \cdot a \cdot \frac{\Delta IC}{IC}$ (f. 3.24).

[89] Defined in this piece of research as the difference between the revenues earned from the ticket sales and the amount of charges for the use of the infrastructure. In reality, railways operators' margin depends on the difference between their total revenues and the total costs they have to face (for instance, the payment of infrastructure charges and other operating costs such as energy, rolling stock, staff, ticket sales, marketing, overheads). For a high speed service, RU's main revenues come from ticket sales since the limited public funding tends to be allocated to pay infrastructure costs or public utility services like suburban trains.

of the influence that the level of charges implemented in the European high speed network can have on railways competitiveness with regard to airways.

5.2. ANALISIS OF THE LINK BETWEEN RAIL INFRASTRUCTURE CHARGES AND REVENUES FROM TICKET SALES

5.2.1. Weight of the infrastructure charges value for high speed links with regard to the revenues from ticket sales

In **figure 5.1** the revenues from the ticket sales (expressed in euros per train-kilometre) for the links constituting the European high speed network have been sorted by increasing order. At the same time, the part of those revenues "used" for paying infrastructure charges has been shadowed. According to these results, the charges-to-revenues ratio of railway operators varies considerably from one link to another and does not follow any correlation with the value of rail infrastructure charges.

More specifically, the weight of the infrastructure charges compared to the revenues ranges from 1,0 % to 52,9 %[90] for the links that constitute the high speed network[91] (see **figure 5.2**), 16,5 % being the average value, that is, for the links analysed, revenues are on average six times higher than infrastructure charges.

The distribution of these values among the different links points to the fact that the application of mark ups to recover part of the investment costs and reflecting the commercial position of the market can considerably influence the value of the infrastructure charges to revenues (from ticket sales) ratio. Sections 5.2.2 and 5.2.3 are devoted to analyse these aspects in detail.

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[90] Without taking into consideration the Oslo – Trondheim link, for which no infrastructure charges are applied to passenger services and excluding the national Estonian and Latvian links (Tallin – Narva and Riga– Recekne, respectively), where the high results of the charges/revenues ratio is due to extremely low ticket fare rates.

[91] Some links are not included in **figure 5.1** because of the lack of data on infrastructure charges and/or revenues from the ticket sales: Belfast – Dublin, Athens – Thessaloniki, Copenhagen – Malmö, Bratislava– Vienna, Prague – Vienna, and Warsaw – Vienna.

FIGURE 5.1 PART OF REVENUES FROM TICKET SALES SET ASIDE TO PAY FOR INFRASTRUCTURE CHARGES ON THE EUROPEAN HIGH SPEED NETWORK

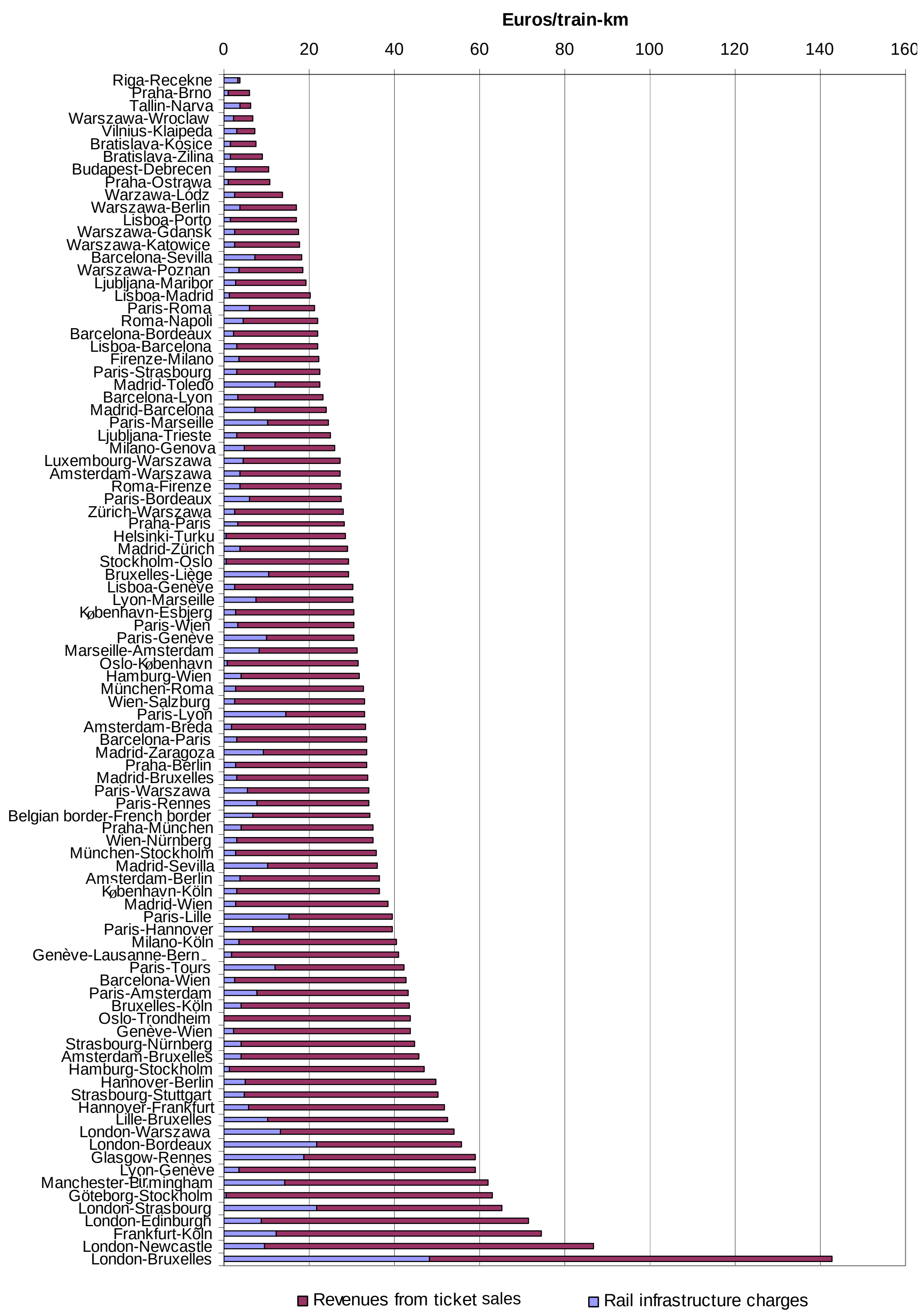
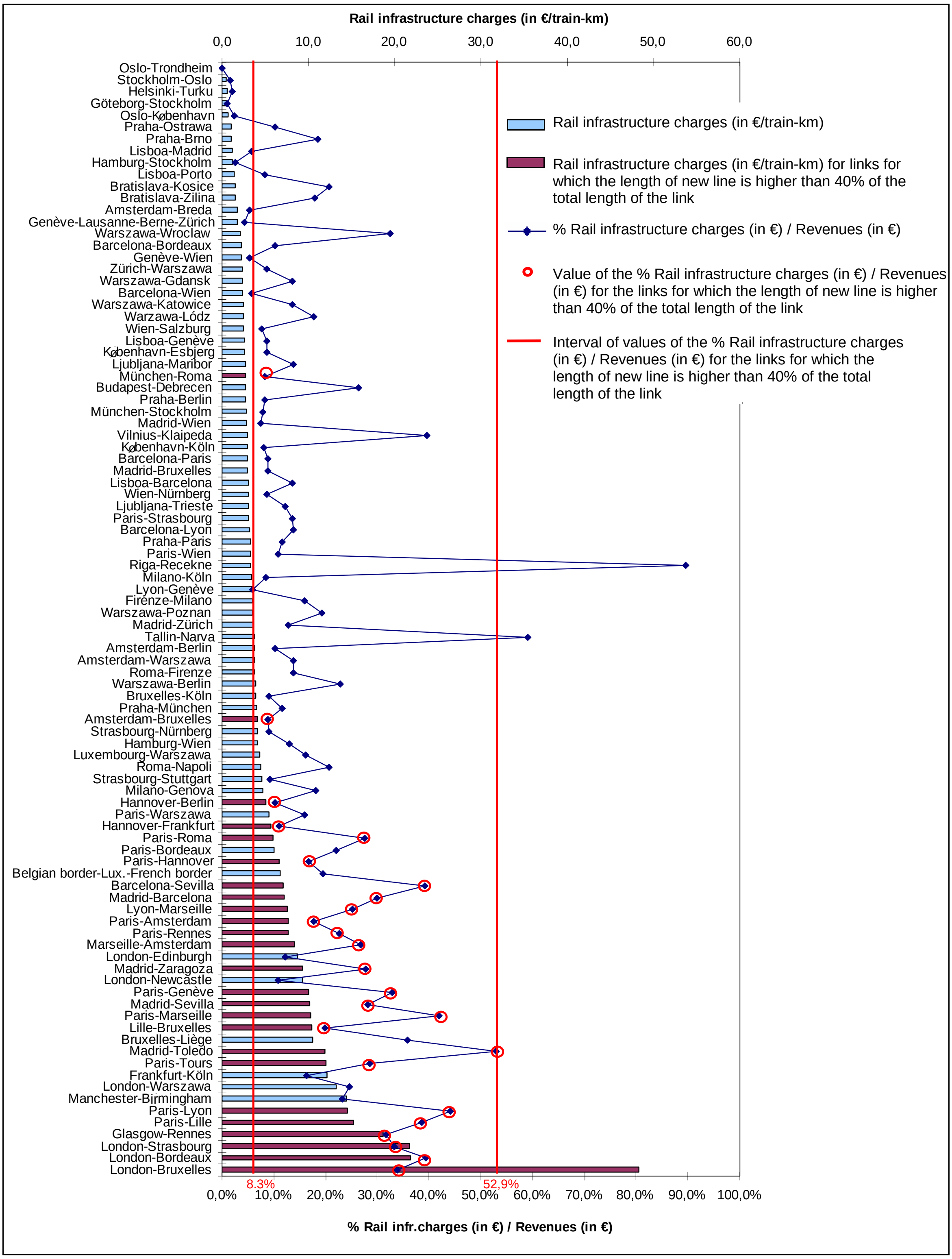


FIGURE 5.2 RAIL INFRASTRUCTURE CHARGES FOR EUROPEAN HIGH-PERFORMANCE PASSENGER SERVICES AND THEIR VALUE COMPARED TO RAILWAYS REVENUES FROM TICKET SALES

Source: Sánchez Borràs et al. (2008a)



5.2.2. Influence of the consideration of investment costs by pricing systems on the charges/revenues ratio

In chapter 4 we saw that the consideration of investment costs by pricing systems (application of mark ups reflecting investment costs) can have an important influence on the value of charges for high speed lines. In this section, whether this influence affects or not the infrastructure charges-to-revenues ratio of railway operators offering high speed services is analysed.

In **figure 5.3** the links analysed have been sorted by increasing order of the value of the "infrastructure charges/revenues from ticket sales" ratio. This figure clearly shows that there are links where revenues are just 2,5 times greater than the cost of infrastructure charges, while for others they exceed 20 times the value of charges, on average being 6 times higher than infrastructure charges. In order to analyse whether these large differences are to any extent related to the recovery of investment costs by infrastructure charges, **figure 5.4** was produced. In it, links are split between types of infrastructure (new lines, upgraded lines and conventional lines) and ordered by their charges/revenues ratio value. The results obtained allow affirming that:

- *The links where revenues are approximately 4 to 2,5 times higher than infrastructure charges* are generally links with new lines in the total length (or almost in the whole length) of the link. In those links where there are different types of infrastructure, more than 40% of the total length of the link is built as new line. As a consequence, links where the charges/revenues ratio is higher than 25% are mainly French, Spanish and British national or international links, where infrastructure charges partly recover investment costs. Exceptions to this tendency are three national Eastern links, namely Budapest – Debrecen (Hungary), Warsaw–Wrocław (Poland) and Vilnius – Klaipeda (Lithuania), built with conventional line, where the high charges/revenues ratio may be explained by the full cost recovery philosophy applied in those countries, but mostly by the low ticket fares.

- *The links where revenues are approximately 7 to 4 times higher than infrastructure charges* are generally links with upgraded lines or a mixture of new or upgraded lines with other types of lines, as well as Eastern links with conventional lines. In the cases where the pricing systems do not recover investment costs, the high weight of infrastructure charges with regard to revenues could be due to the application of mark ups according to the commercial position of the market (such could be the case of Italian links) or to low revenues (as would be the case of Eastern countries). The analysis of the influence of the application of mark ups

FIGURE 5.3 INFRASTRUCTURE CHARGES/REVENUES RATIO FOR THE LINKS CONSTITUTING THE EUROPEAN HIGH SPEED NETWORK

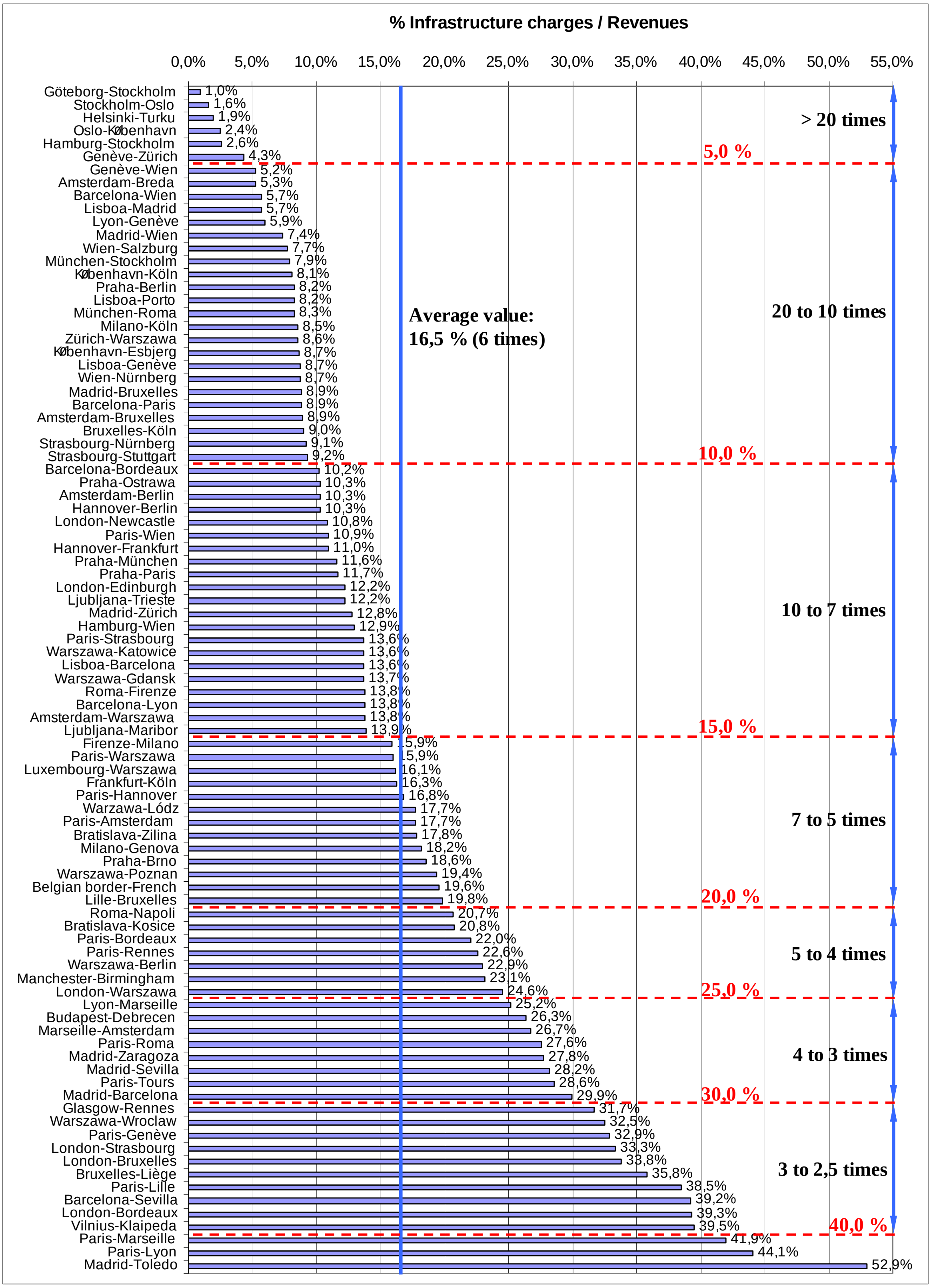
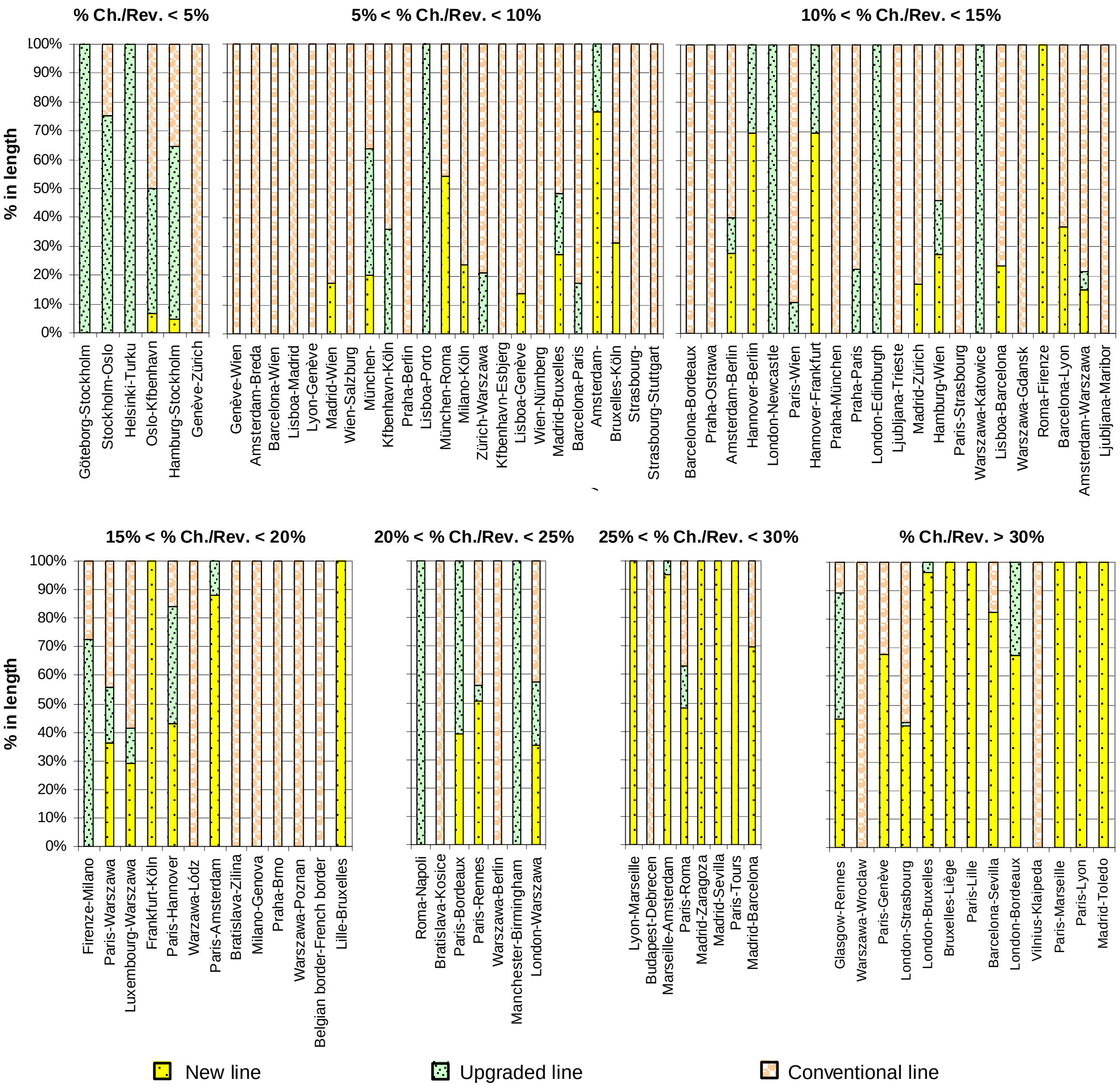


FIGURE 5.4 PERCENTAGE IN LENGTH OF THE DIFFERENT TYPES OF LINES FOR THE LINKS ANALYSED, ORDERED BY INCREASING RANGE OF CHARGES/ REVENUES RATIO VALUE



Remark: The Bruxelles-Liège link is composed by new line and upgraded line. However, since the percentages are not known, it has been indicated as being composed of only new line.

according to the commercial position of the market on the charges/revenues ratio will be analysed in the next section (section 5.2.3).

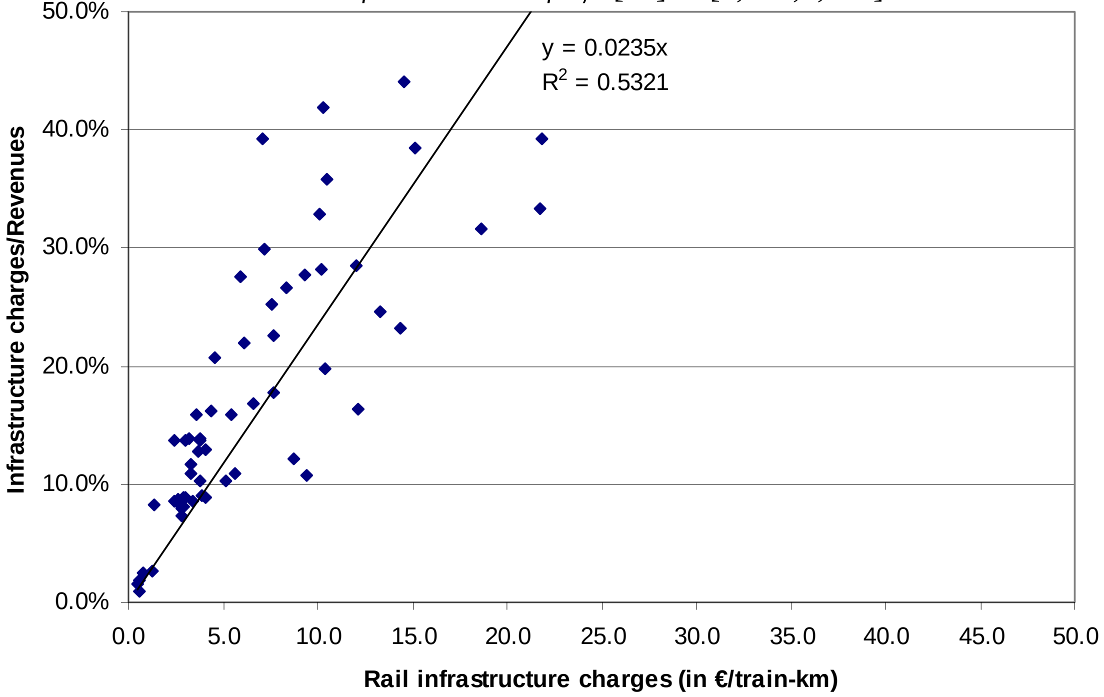
- *The links where revenues are approximately 20 to 7 times higher than infrastructure charges* are generally links with conventional line in almost the whole length of the link. Exceptions to this tendency are, on the one hand, some links with upgraded lines crossing Portugal, the United Kingdom and Poland; on the other hand, the high speed line Rome-Florence, for which railway charges do not cover investment costs at all; and finally, links with new and upgraded lines, mainly situated in Germany (where infrastructure charges are mainly fixed according to the usage of the line rather than according to the type of infrastructure) and in the Netherlands (where investment costs are not covered by infrastructure charges).

- *The links where revenues are at least 20 times higher than infrastructure charges* are links which are mainly on Scandinavian countries, as well as links shorter than 100 km. For such links, the type of line does not seem to play a role. In part, this is due to the fact that most Scandinavian countries do not set charges so as to partly recover infrastructure costs.

FIGURE 5.5 CORRELATION BETWEEN THE RAIL CHARGES/REVENUES RATIO AND THE VALUE OF INFRASTRUCTURE CHARGES

$y = \beta x$

Dependent variable: y = charges/revenues
Explanatory variable: x = rail infrastructure charges (€/train-km)
Regression coefficient: β = 0,0235
95% confidential interval for β: [CI]: = [0,021;0,026]



Remark: Conventional lines, as well as the London-Brussels link, are excluded from the analysis. On the one hand, because pricing systems do not apply mark ups for the recovery of investment costs in conventional lines. On the other hand, because the value for the London-Brussels link is not representative for the general tendency.

According to what has been presented, it can be affirmed that for the representative European links, RU's revenues from ticket sales are always at least 2,5 times higher than the infrastructure charges that they have to pay to IM for the use of infrastructure. Nevertheless, it is in links with new lines (the ones that respond to the technical definition of high speed lines) where the amount of charges is closer to RU's revenues earned from ticket sales. **Figure 5.5**, where the value of infrastructure charges has been related to the charges-to-revenues ratio for all the links analysed except for the ones with conventional line all over their length (for which pricing systems do not consider investment costs), confirms this tendency. Thus, higher charges tend to imply higher charges/revenues ratios.

5.2.3. Influence of the consideration of the commercial position of the market on the charges/revenues ratio

According to the results presented in section 5.2.2, the consideration of investment costs by pricing systems affects the infrastructure charges/revenues ratio but in some cases values seem to be more correlated with mark ups on the commercial position of the market. Therefore, the subsequent paragraphs focus on the influence that the consideration of the commercial position of the market may have on the value of the infrastructure charges-to-revenues ratio.

In chapter 4 it was proved that infrastructure charges for high speed services (running on new lines) are strongly correlated to the commercial speed, besides being very sensitive to the travel time. In this section, the influence that both the commercial speed and the travel time can have on the value of the charges/revenue ratio will be considered.

In **figure 5.6** the value of the rail infrastructure charges/revenues ratio has been presented as dependent variable and the commercial speed as explanatory variable. If we do not take into account the values for the Riga – Recekne and the Tallin – Narva links[92], it looks as if the value of the charges-to-revenues ratio tends to increase with faster commercial speeds, following the same tendency observed between rail infrastructure charges and the commercial speed.

Since the results of chapter 4 show that the type of infrastructure plays an important role in the correlation existing between infrastructure charges and the commercial speed[93], in

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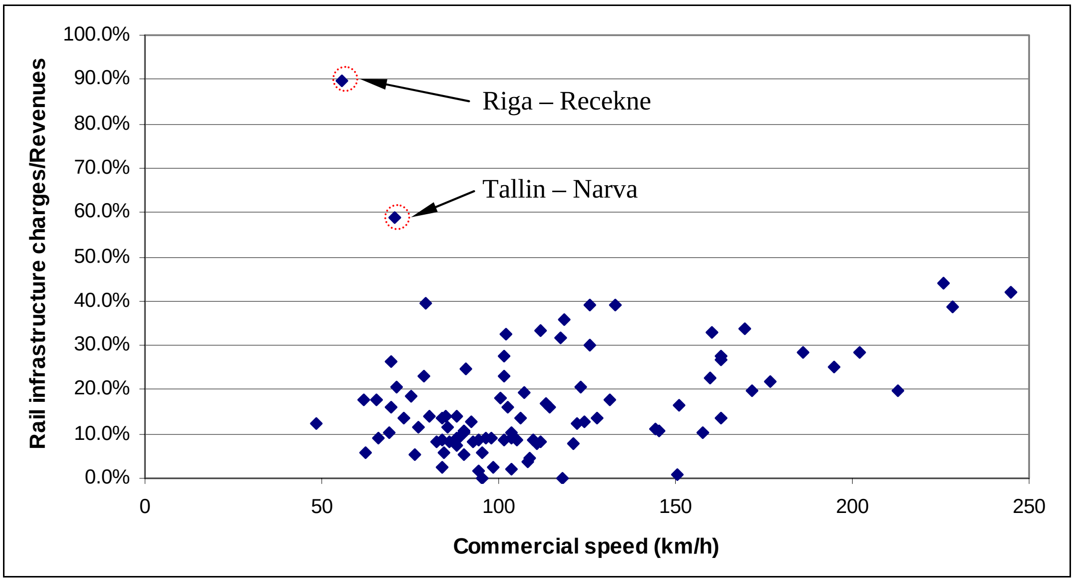
[92] As outlined in section 5.2.1, the values for those links are extremely high due to the very low value of revenues from ticket sales.

[93] For conventional lines it was not possible to establish a correlation between infrastructure charges and the commercial speed, while for new lines infrastructure charges are very sensitive to an increase of the commercial speed.

figure 5.7 the results have been presented distinguishing by type of line. It can be seen that while no correlation can be established between the value of rail charges/revenues ratio and the commercial speed for conventional lines, the correlation between these two parameters is very strong for links constituted by new infrastructure (new lines). So strong, that in links where the type of infrastructure is mixed, the correlation can still be inferred, even if the new infrastructure is only found in a segment of the link.

FIGURE 5.6 CORRELATION BETWEEN THE CHARGES/REVENUES RATIO AND THE COMMERCIAL SPEED

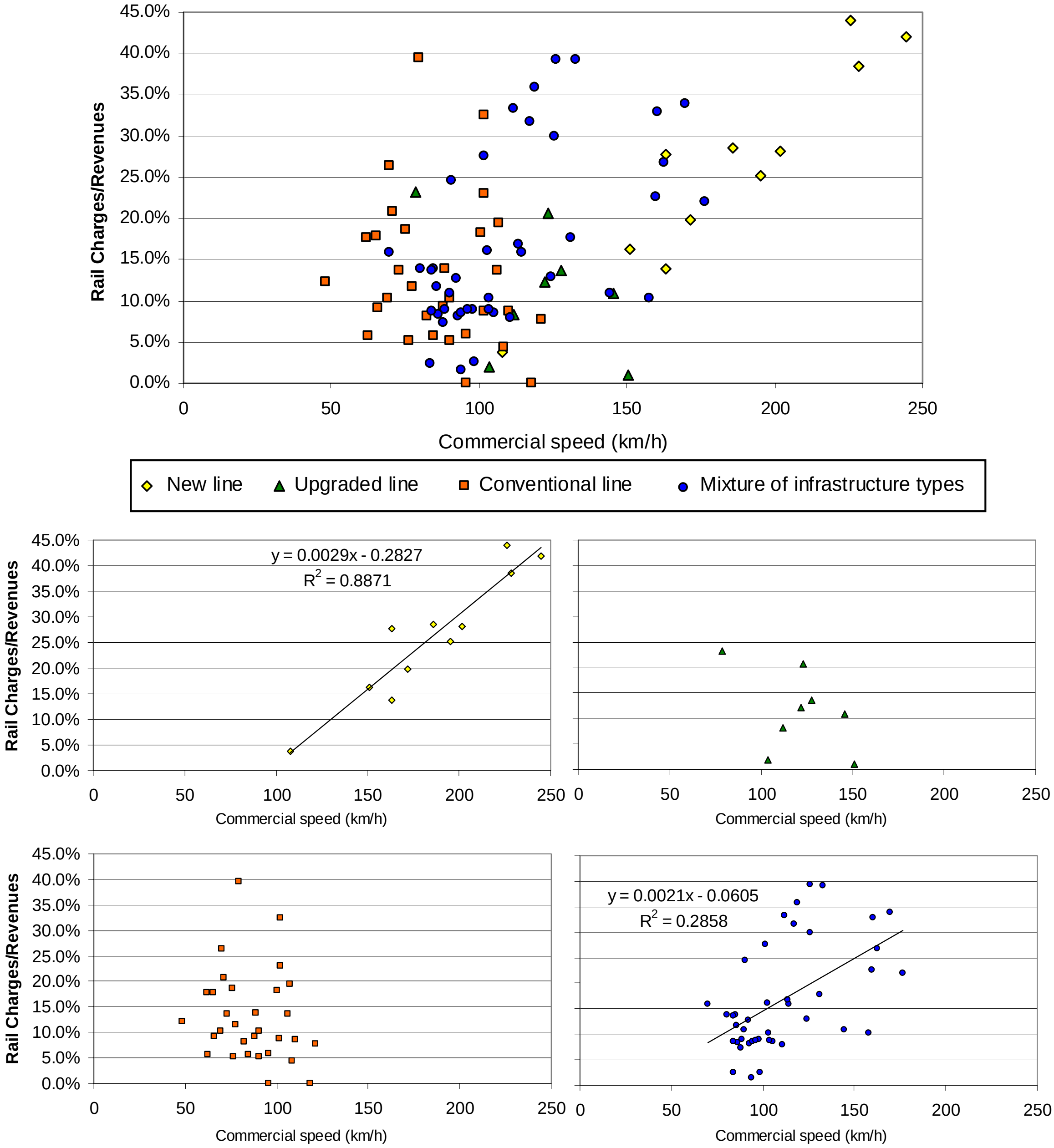


However, the type of infrastructure does not allow establishing a clear correlation between the charges/revenues ratio and the travel time (see **figure 5.8**). Therefore, in **figure 5.9** the analysis has been presented at national level, for those countries where different high speed or high performance links constitute the network modelled in chapter 3. The aim of this was to analyse whether some tendency could be found in the policies of railways operators regarding the definition of ticket sales according to the value of infrastructure charge or the other way round.

On the left hand side of **figure 5.9**, the correlation between the charges/revenues ratio and the travel time has been presented, while on the right hand side the results obtained in chapter 4 are summarised. **Figure 5.9** shows that:

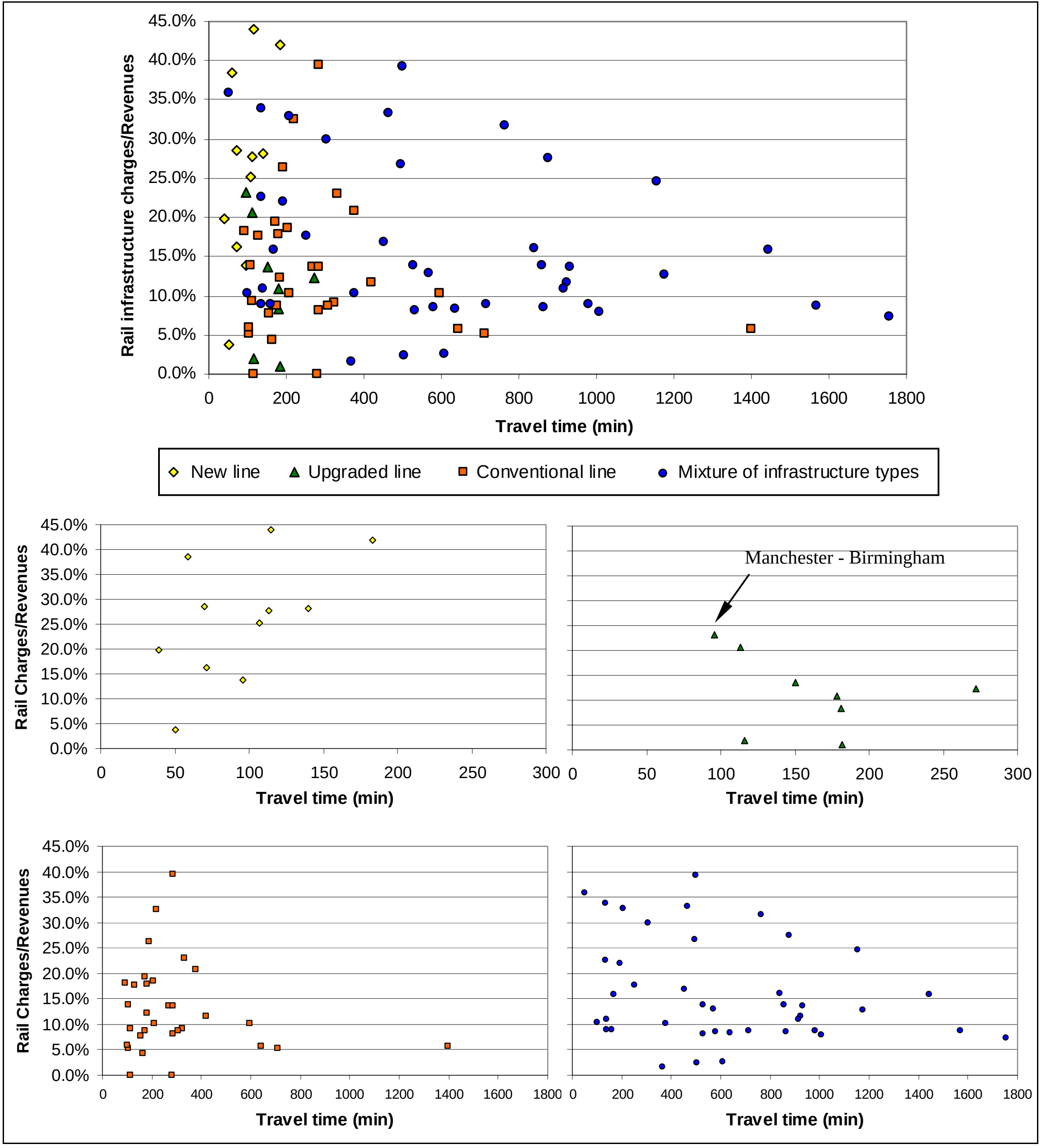
- The value of the charges/revenues ratio is especially high for French and Spanish high speed links. Indeed, only in these two countries is the value above 25%, with the ratio reaching values up to approximately 40%-45%.

FIGURE 5.7 CORRELATION BETWEEN THE CHARGES/REVENUES RATIO AND THE COMMERCIAL SPEED, DISTINGUISHING BY TYPE OF INFRASTRUCTURE



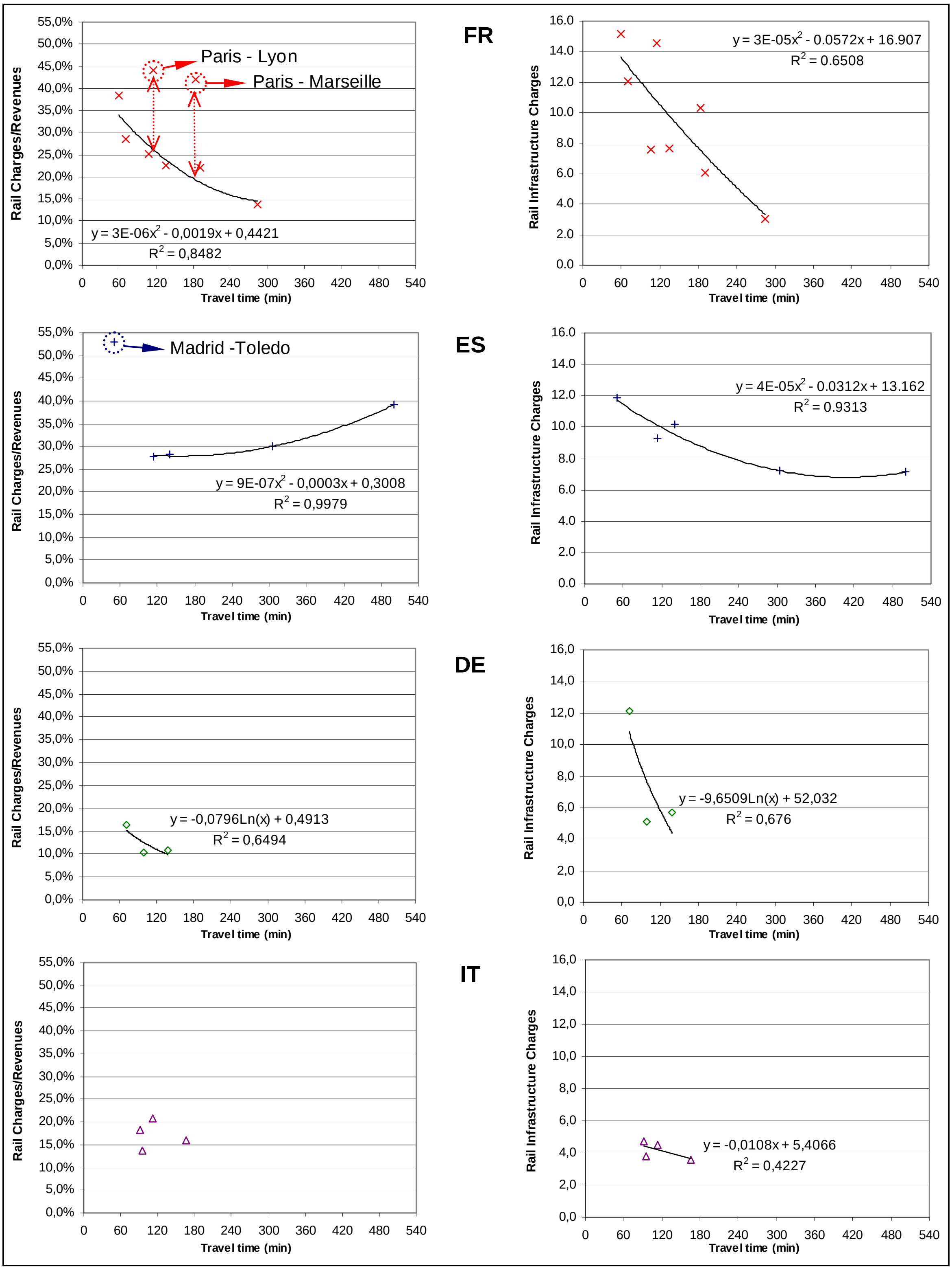
Remark: For this analysis, the values for the links crossing the Channel Tunnel are in line with the general tendency. Therefore they have been represented in the corresponding graphic and taken into consideration for the analysis.

FIGURE 5.8 CORRELATION BETWEEN THE CHARGES/REVENUES RATIO AND THE TRAVEL TIME, DISTINGUISHING BY TYPE OF INFRASTRUCTURE



- *In France*, where charges for high speed services seem to be very sensitive to the travel time (see chapter 4), the charges/revenues ratio is strongly correlated to the travel time. However, the Paris – Lyons and Paris – Marseilles links, the most important French high speed links, seem to follow a different pattern; indeed, according to the travel time required to run the distance separating these cities, the charges/revenues ratio would be expected to amount approximately 20%-25%, but in those links the ratio is comprised between 40% and 45%.

FIGURE 5.9 CORRELATION BETWEEN INFRASTRUCTURE CHARGES/REVENUES AND THE TRAVEL TIME PER COUNTRY



- *In Spain,* where the influence of the travel time on the value of charges for high speed lines is noticeable but lower than in France (see chapter 4), the charges/revenues ratio is strongly correlated to the travel time. In contrast to what happens in France, in Spain the value of the ratio analysed increases with an increase of the travel time. This can only be explained by a RU's fare policy consisting of applying lower ticket fares to longer (in terms of time) journeys. It has to be noted that the Madrid – Toledo high speed link (90 km), which is operated as high speed regional service, does not follow the tendency observed for long distance links.

- *In Germany,* where the value of the charges/revenues ratio ranges from 10,3% to 16,3% for the high speed links analysed, the charges/revenues ratio seems to decrease with an increase of the travel time, as it happens in France. Nevertheless, in Germany the values of the charges/revenues ratio seem to be approximately 15% lower than the ones registered in France for a given travel time (comprised between one and two hours). It has to be mentioned that in terms of infrastructure charges, the values in Germany tend to be about 4 €/train-km lower than in France for a given travel time (comprised between one and two hours).

- *In Italy,* where the value of the charges/revenues ratio ranges from 13,8% to 20,7% for the high speed links analysed, the charges/revenues ratio does not seem to be correlated to the travel time.

According to the remarks presented in the preceding paragraphs, the charges-to-revenues ratio for railway operators offering high speed services are higher the shorter the travel time is. Exceptions to this tendency are found in Spain, where the value remains almost invariable for travel times up to three hours and only then it increases, and in Italy, where no tendency can be established.

5.3. ANALYSIS OF THE CHARGES-TO-REVENUES RATIO FOR HIGH SPEED RAILWAYS COMPARED TO THE ONE FOR AIRWAYS

5.3.1. Comparison of the charges-to-revenues ratio for railways and airways

In this section, the charges-to-revenues ratio for railways is compared to the one for airways, with the aim of determining whether railway operators offering high performance railway services have to dedicate a bigger part of their revenues (in percentage) to pay infrastructure charges than airways carriers covering a same Origin-Destination (OD) link.

The results obtained are presented in **figure 5.10** and were calculated assuming load factors of 65% for railways and 70% for airways, a TGV Duplex in a 500 seats configuration and an A320 airplane with a maximum takeoff weight of 73,5 tones and in a 150 seats configuration (see chapter 3 for more details on the calculation assumptions).

According to the results presented in **figure 5.10**, three different behavioural tendencies may be distinguished:

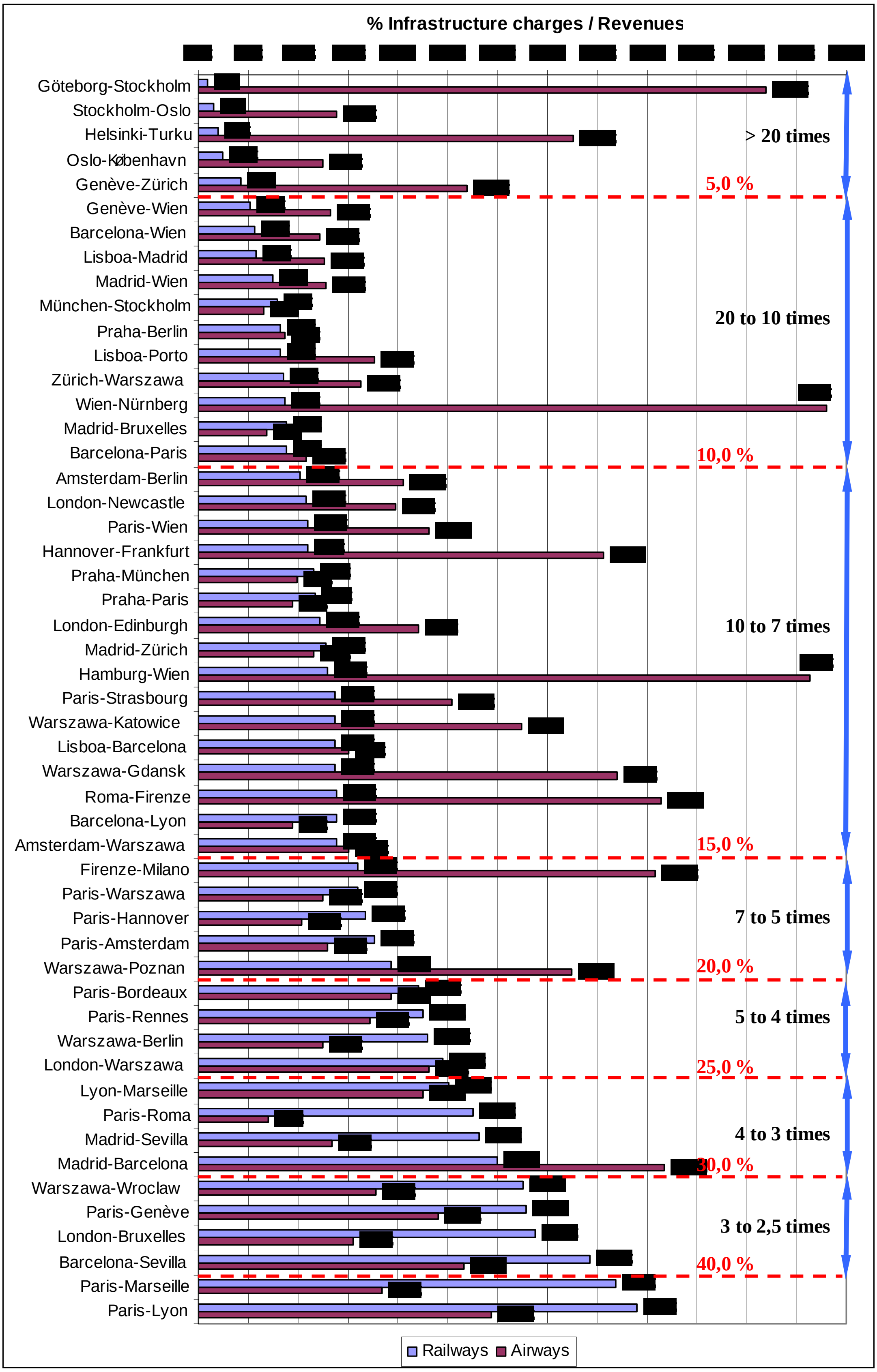
- *Value of infrastructure charges-to-revenues from ticket sales ratio predominantly higher for airways than for railways*: This tendency seems to apply to links for which the infrastructure charges/revenues ratio is lower than 15% (railway revenues at least 7 times higher than rail infrastructure charges). As presented in section 5.2, these links are generally links with conventional line in almost the whole length of the link as well as Scandinavian links. Exceptions are mainly found in international links departing from Prague and crossing Germany, and links with their origin in Spain.

- *Value of infrastructure charges-to-revenues from ticket sales ratio indifferently higher or lower for airways than for railways (transition zone)*: This ambiguous tendency is observed in links where the railways infrastructure charges/revenues ratio is comprised between 15% and 20% (revenues 5 to 7 times higher than infrastructure charges).

- *Value of infrastructure charges-to-revenues from ticket sales ratio predominantly higher for railways than for airways*: This tendency seems to apply to links where the infrastructure charges/revenues ratio is higher than 20% (railway revenues up to 5 times higher than rail infrastructure charges). As presented in section 5.2, links belonging to this group are generally those with new lines in the total length of the link (or at least in more than 40% of the total length of the link). It has to be remarked that the Madrid-Barcelona link is an exception of this tendency.

The existence of these three tendencies points to the fact that the consideration of investment costs and the commercial position of the market by railway pricing systems may influence the results of the comparison of the infrastructure charges-to-revenues ratio for railways and airways. Therefore, sections 5.3.2 and 5.3.3 focus on the analysis of the existence of a correlation between a higher charges-to-revenues ratio for railways than for airways and the consideration of investment costs and the commercial position of the market by railway infrastructure charging systems.

FIGURE 5.10 WEIGHT OF RAIL INFRASTRUCTURE CHARGES AND AIRWAYS CHARGES COMPARED TO THE REVENUES FROM TICKET SALES



5.3.2. Analysis of the influence that the consideration of investment costs by railway pricing systems may have on the competitiveness of high speed railways compared to airways

Figure 5.10 showed that there are numerous links where the charges/revenues ratio is higher for airways than for railways. Nevertheless, the opposite situation is also observed in other links. In **figure 5.11** links have been sorted out by increasing order of the charges/revenues ratio and split into type of line (new line, upgraded line and conventional line). In addition, the difference between the charges-to-revenues ratio of a railway operator offering a high speed service and the charges-to-revenues ratio of an airline carrier connecting the same cities as the railway operator has been presented.

According to the results presented in **figure 5.11**, links served by high speed lines or high quality services where the percentage of new lines is above 30% of the total length of the link, have higher infrastructure charges/revenues ratios for railways than for airways (the Hanover-Frankfurt, the Rome-Florence and the Madrid-Barcelona links are exceptions to this rule because of their specificities[94]). This result (higher infrastructure charges/revenues ratios for railways than for airways for links supplied by high speed lines or high quality services) was to be expected: on the one hand, because of the strong differences existing between the infrastructure requirements for high speed lines (or high quality services) and conventional services; on the other hand, because it is logical that higher infrastructure costs give rise to higher infrastructure charges if the charging systems are defined to partly cover investment costs. Furthermore, it is to be noted that in the case of airways, the differences across infrastructure requirements for different types of services are much lower than for railways.

However, the analysis would not be complete without determining how much the comparison of the charges-to-revenues ratio between railways and airways really amounts to from an economic point of view. The chart in the middle of **figure 5.11** shows that even if in links with more that 30% of their length in new line railway operators have to dedicate a higher percentage of their revenues to pay charges for the use of infrastructure than airways operators, in some cases this does not imply that the margins over infrastructure charges are lower in absolute terms than the ones of airways operators. Indeed, it can be observed that:

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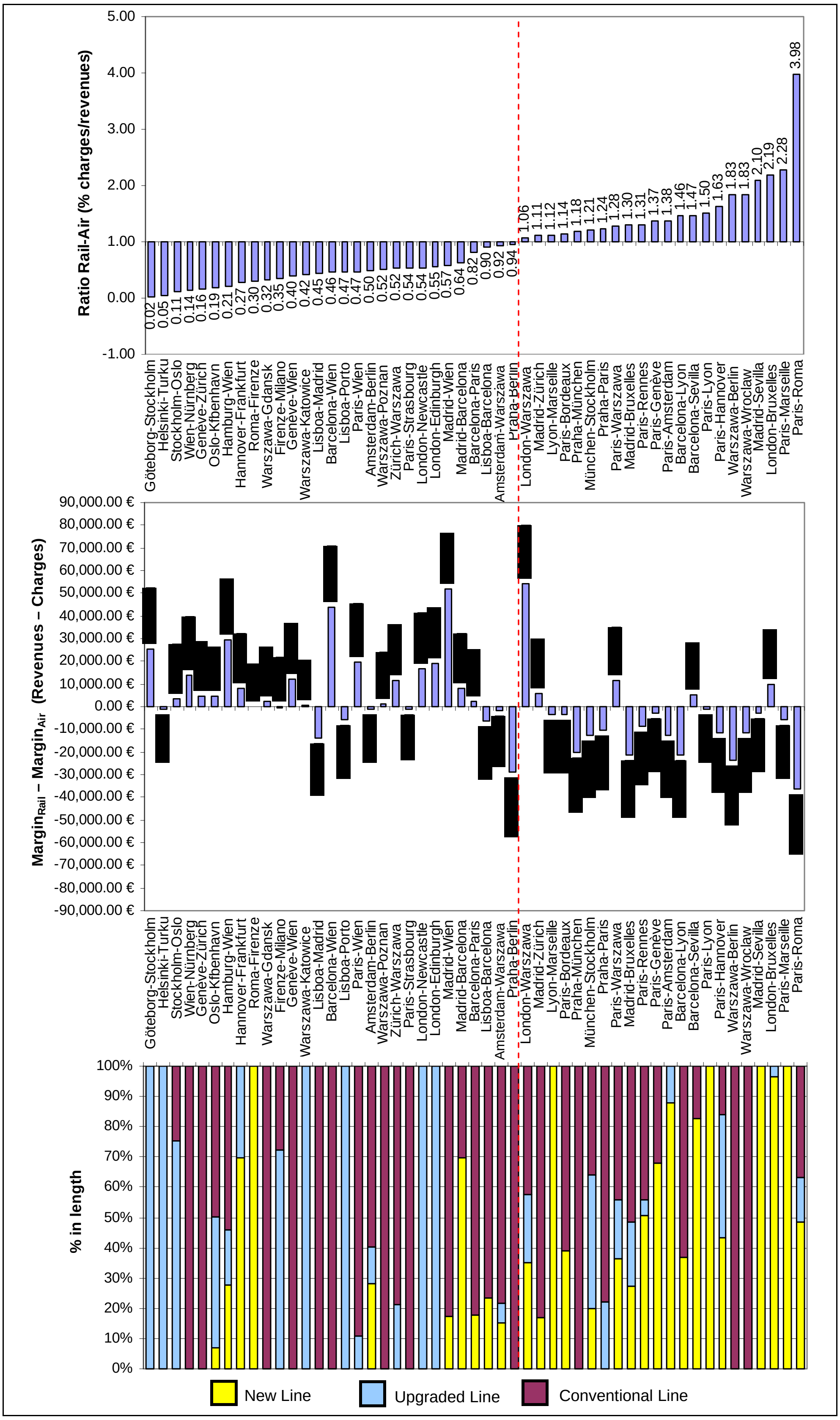
[94] On the one hand, the Italian infrastructure charging system does not cover investment costs. On the other hand, the charges defined by ADIF for the new Madrid-Barcelona high speed line are applicable only from February 2008 on, when the works of the new line between the two cities were finished and the link could be considered as a new line in its whole length. Regarding the German exception, different aspects other than the consideration of investment costs seem to explain the results obtained.

FIGURE 5.11 COMPARISON OF THE CHARGES/REVENUES RATIO AND PROFIT FOR THE RAIL AND THE AIR MODES IN SELECTED EUROPEAN HIGH PERFORMANCE LINKS AND CORRELATION WITH THE TYPE OF LINE



- In the links crossing the Channel Tunnel, the margin over infrastructure charge in absolute terms is higher for railway operators than for airways operators. Since charges for the links crossing the Channel Tunnel are the most expensive in the railway European framework (from approximately 19 €/train-km to about 48 €/train-km[95] compared to the 0 €/train-km to 15 €/train-km registered in the other links constituting the European high speed network), those results show that the ticket fare rates for the railway services crossing the Channel Tunnel are considerably higher. Indeed, their amounts range from about 54 €/train-km to approximately 143 €/train-km. In the other other links however, only those in the United Kingdom (London-Newcastle and Manchester-Birmingham links) and Sweden (Göteborg-Stockholm link) saw revenues beyond 60 €/train-km.

- In national Spanish links, the margin over infrastructure charge in absolute terms is higher for railway operators than for airways carriers in those services running on links which are not fully built as new lines (for instance, Barcelona-Sevilla and Madrid-Barcelona[96]).

- The Madrid-Zurich and Paris-Warsaw links register higher margins over infrastructure charges for railways operators than for airways carriers offering flights on those links.

With regard to the links where the charges-to-revenues ratio between railways and airways is lower than one (see **figure 5.11**), the railways operators' margin over infrastructure charge is in general terms higher than the one of airline carriers offering the same service. The main exceptions are found in Portuguese national and international links, as well as in the Prague-Berlin link.

Despite all the aforementioned exceptions, it can be affirmed as a general rule, that:

- Higher infrastructure charges-to-revenues ratios for railways than for airways (values above 1 in **figure 5.11**) imply higher margins over infrastructure charges for airways carriers than for railway operators running services on such links.

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[95] Rail infrastructure charges amount 13,3 €/train-km in the London-Warszaw link. This lower value is due to the long length of the link (1.743 km).

[96] The calculations were made for 2006, when the Madrid-Barcelona new line had not yet been open to commercial operation (February 2008 saw the complete opening of the new line Madrid-Barcelona to commercial operation).

- Lower infrastructure charges-to-revenues ratios for railways than for airways (values below 1 in **figure 5.11**) imply higher margins over infrastructure charges for railways operators than for airways carriers offering services on such links.

According to these facts, it can be affirmed that the consideration of investment costs by railways infrastructure charging systems results in lower margins over infrastructure charges for RUs offering high speed services than for airways carriers. As a result of that, compared to railway operators offering conventional services on conventional railway lines, railway undertakings offering high speed services on high speed lines lose their advantage with regard to airways in terms of margins over infrastructure charges.

5.3.3. Analysis of the influence that the consideration of the commercial position of the market by railway pricing systems may have on the competitiveness of high speed railways with regard to airways

The influence that the consideration of the commercial position of the market by railway pricing systems may have on the competitiveness of high speed railways compared to airways has been analysed on the basis of the value of the charges-to-revenues ratio between railways and airways.

According to the results obtained (presented in **figure 5.12),** when railways reach commercial speeds that can directly compete with the ones of the air mode (commercial speeds above 165 km/h), the percentage of incomes from ticket sales dedicated to pay infrastructure charges is higher for railways than for airways. That means that the charges-to-revenues ratio is more unfavourable to the rail than to the air mode[97].

Despite this situation, no further correlation could be established between the charges-to-revenues ratio between railways and airways and the commercial speed. Indeed, for speeds lower than 165 km/h, the value of the commercial speed seems not to have a direct effect on the value of the ratio analysed. However, it is to be noted that links where commercial speeds are above 165 km/h correspond to new lines (yellow rhombus) or a combination of new and upgraded lines, with the length of new lines above 40% of the total length of the link. Given that chapter 4 and the preceding sections of chapter 5 have ascertained that rail infrastructure charges are strongly correlated with the commercial speed and that there is a strong correlation between the rail infrastructure charges-to-revenues ratio and the commercial speed in links with new lines, it may be affirmed that the consideration of the

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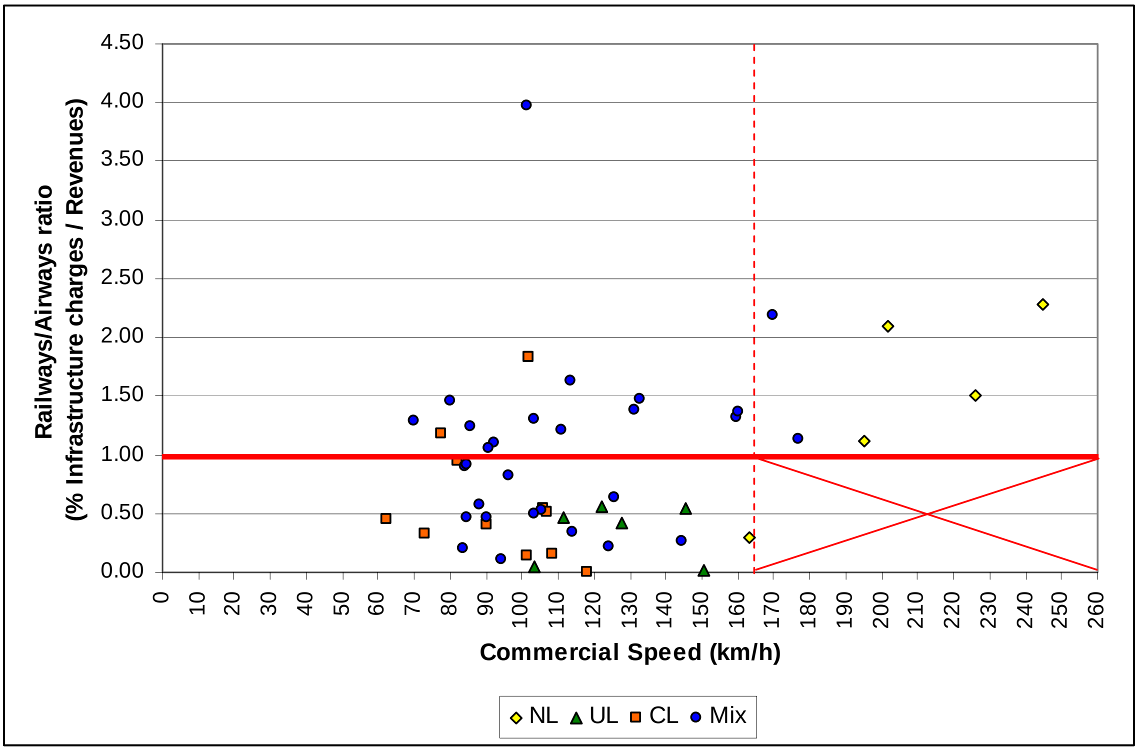
[97] In section 5.3.2 it has been verified that higher infrastructure charges-to-revenues ratios for railways than airways imply, in general terms, lower margins over infrastructure charges for railway operators than for airways carriers.

commercial position of the market by railway pricing systems negatively affects the competitiveness of high speed railways in front of airways.

FIGURE 5.12 CORRELATION BETWEEN THE WEIGHT OF RAIL INFRASTRUCTURE CHARGES AND AIRWAYS CHARGES COMPARED TO THE REVENUES FROM TICKET SALES AND THE COMMERCIAL SPEED



5.4. COMMENTS ON THE LINK BETWEEN RAIL INFRASTRUCTURE CHARGES AND REVENUES FROM TICKET SALES

The results presented in this chapter have shown that the application to high speed lines (and services) of mark ups reflecting investment costs and the commercial position result in higher charges-to-revenues ratios compared to the ones registered for conventional lines. This may be affecting the competitiveness of RUs offering high speed services, since their margins over infrastructure charges have been found to be lower for RUs offering high speed services than those of airways carriers, whilst the situation is the reverse in links where conventional railway services are offered.

Attention has to be drawn to the fact that the prices used in this research are based on the theoretical assumption that the travel studied represents the whole of the travellers in the train (see chapter 3). This assumption leads to a surcharge of the revenues compared to reality and, consequently, the influence of the mark ups above marginal costs implemented in the rail charging systems on the European high speed network could even be higher than stated.

The fact that unit values for infrastructure charges are well above marginal costs and higher than the optimal mark up calculated in chapter 1 (as seen in chapter 4), added to the aforementioned results, shows that many IMs' charges may be far from the optimum infrastructure charge value. This discrepancy is also visible from the railway operators' point of view. Indeed, when a RU seeks a certain profitability for high performance services, in particular when it is a question of facing a competition characterised by reduced prices, a pricing design representing an important percentage of the total cost could result in a limitation to the development of offers on the new high speed lines. This was for instance the case of Thalys, which had to reduce its number of trains due to an increase in the infrastructure charge. The reduction of trains was aimed at raising the load factor and, therefore, the revenues per train in order to render Thalys profitable. On the other hand, the national French operator, SNCF, in 2008 was planning to increase its ticket fares by 2% in all its high speed trains in order to face the increase in rail infrastructure charges to be paid to the French infrastructure manager, RFF (Vía Libre, 2008). The question is how it will influence the market share of high speed railways compared to that of airways.

Even if increased access charges aimed at recovering capital costs are compliant with Directive 2001/14/EC, according to Smith (2006), the spirit should be such that the traffic can afford to use the infrastructure. The next chapter is devoted to quantifying the competitive impact of the actual levels of HSR charges.

CHAPTER 6

ANALYSIS OF THE IMPACTS THAT CURRENT PRICES CHARGED TO HS TRAINS ARE LIKELY TO HAVE ON HSR COMPETITIVENESS

6.1. INTRODUCTION ON THE IMPACT THAT THE VALUE OF RAIL INFRASTRUCTURE CHARGES MAY HAVE ON THE RAILWAYS COMPETITIVE POSITION

Railways competitiveness compared to other modes of transport is, in some terms, determined by the commercial speed (closely related to line performances: new line, upgraded line, conventional line), the total travel time (related to the total length of the link and line performances) and the ticket fares. However, the introduction of infrastructure charging systems in the new European railways scenario meant introducing a new element in this field. As it was introduced in chapter 2 the demand sensitivity to ticket fare rates points to the fact that an increase in the charge for the use of infrastructure or too high an infrastructure charge level can have an important effect on the HS railways market share compared to airways, especially for travel times of 3-4 hours.

In chapter 5, some correlations were established between the rail infrastructure charges-to-revenues ratio and the travel time in two countries, namely France and Spain, both applying important mark ups on charges for high speed trains running on high speed lines. In these countries it is possible to establish how the infrastructure charges-to-revenues ratio is related to the market share[98] (see **figures 6.1** and **6.2**).

Figure 6.1 shows the econometric analysis carried out for France using the charges-to-revenues ratio as the dependent variable and the market share as explanatory variable, without taking into account the two main French high speed links (Paris-Lyons and Paris-Marseilles), which do not follow the general French tendency. According to the results obtained, in France the charges-to-revenues ratio would increase with the market share according to a positive polynomial function. These results seem to show that mark ups may have been imposed taking careful consideration of the market position of RUs in the market segment in question, i.e. there seems to be a clear market-based pricing.

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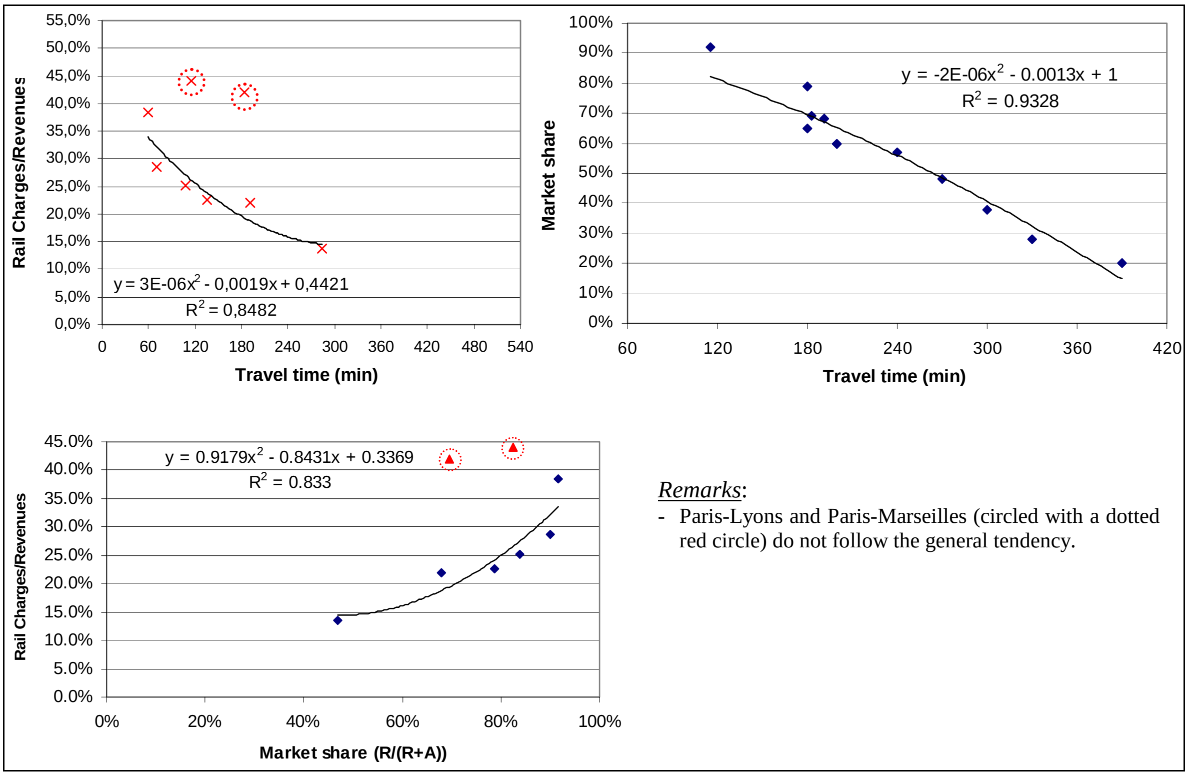
[98] The results of this correlation are valid for 2006 and in journeys starting at 8 a.m. (see chapter 3 for more precisions on the calculation hypotheses).

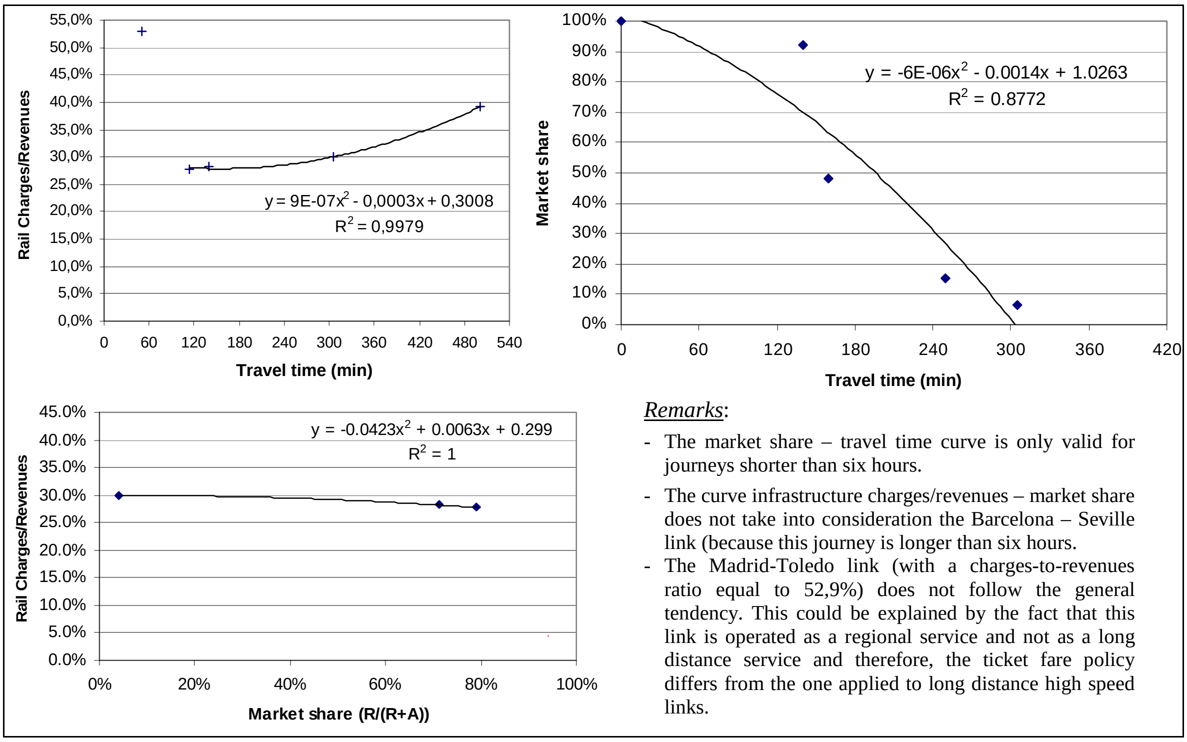
FIGURE 6.1 LINK BETWEEN THE RAIL INFRASTRUCTURE CHARGES/ REVENUES RATIO AND THE MARKET SHARE FOR FRENCH HIGH SPEED LINKS IN 2006



Remarks:

- Paris-Lyons and Paris-Marseilles (circled with a dotted red circle) do not follow the general tendency.

FIGURE 6.2 LINK BETWEEN THE RAIL INFRASTRUCTURE CHARGES/REVENUES RATIO AND THE MARKET SHARE FOR SPANISH HIGH SPEED LINKS IN 2006



Remarks:

- The market share – travel time curve is only valid for journeys shorter than six hours.
- The curve infrastructure charges/revenues – market share does not take into consideration the Barcelona – Seville link (because this journey is longer than six hours.
- The Madrid-Toledo link (with a charges-to-revenues ratio equal to 52,9%) does not follow the general tendency. This could be explained by the fact that this link is operated as a regional service and not as a long distance service and therefore, the ticket fare policy differs from the one applied to long distance high speed links.

Figure 6.2 presents the results of the same analysis for the Spanish case. The results show that contrary to what has been observed in France, in Spain the infrastructure charges-to-revenues ratio does not increase with an increase of the railways' market share. According to these results, the ratio for high speed links hardly varies with market share and if it does, it tends to decrease with an increase of railways market share with regard to the one of airways. Therefore, there is no real evidence of market-based pricing.

Those results lead to suspect that the mark ups have not always been "imposed after careful consideration of the most efficient way of doing so and their consequences for the market position of railway undertakings in the market segment in question", as IMPRINT-NET (2008) recommended it should be done.

In order to try to understand how the level of infrastructure charges can affect the competitiveness of high speed services with regard to airways, the analysis has been divided into two main parts:

- Firstly, the impact that current prices charged in the main European countries operating high speed trains are likely to have on traffic levels is analysed.
- Secondly, the impact that current prices charged in the main European countries operating high speed trains are likely to have on mode split is analysed.

6.2. ANALYSIS OF THE IMPACT THAT A REDUCTION IN RAIL INFRASTRUCTURE CHARGES CAN HAVE ON TRAFFIC VOLUMES

The impact that a reduction in rail infrastructure charges is likely to have on traffic volumes has been assessed on the basis of f. 3.25 presented in chapter 3. From f. 3.25, it is possible to affirm that the impact derived from a reduction in infrastructure charges will be higher the higher *a* is, i.e. the higher the infrastructure charges/revenues ratio is, the higher the coefficient $\frac{\varepsilon}{1+\varepsilon}$ is as well as.

Concerning the value of *a*, the results presented in chapter 5 have shown that it is in links with new lines that *a* sees higher values, while the lowest ones are registered in conventional lines. At the same time, the analysis of the results shows that above commercial speeds of 150 km/h, *a* increases proportionally and considerably with an increase of the commercial speed (see **figure 5.7**). Consequently, for new high speed lines, the current charging and pricing levels are expected to bring about higher changes in traffic volumes than in conventional lines.

With regard to the value of the price elasticity of demand, a similar value applies to a given market segment[99]. For the present analysis it has been assumed that high speed runs on the European high speed network constitute a single market segment and therefore, the value of the price elasticity of demand for those can be considered to be the same for such runs[100].

Evidence on fare elasticity for high speed railways can be found in Wardman (1998). According to this author, the fare elasticities for Eurostar do not vary greatly across the different fare increases and amount on average approximately -0,50 for business and -0,70 for leisure. It could be expected that the improvement of yield management in the railway field during the last ten years may have reduced the elasticity published by Wardman (1998). However, according to Crozet (2007) price elasticity for high speed trains is supposed to range from -0,70 (Lyons-Paris line) to -1,50 (Paris-Nice line).

Since the present study focuses on high speed runs departing at 8 a.m. from the origin point (see chapter 3 for more details about the calculation assumptions), and in order not to overestimate the impact on traffic volumes of a variation in rail infrastructure charges, the value of fare elasticity used for the calculations was the one for business trips published by Wardman (1998), that is, -0,50. Therefore, the relative change in traffic volumes for the high performance services departing at 8 a.m. from the origin point and running on the European high speed network can be expressed as:

$$\frac{\Delta Q}{Q} = \frac{-0{,}50}{1+\left(-0{,}50\right)} \cdot a \cdot \frac{\Delta IC}{IC} = -a \cdot \frac{\Delta IC}{IC} \qquad \text{(f. 6.1)}$$

The analysis of the impact that actual prices charged in the main European countries operating high speed trains are likely to have on traffic levels has been carried out using f. 6.1 and assuming:

- Firstly, a reduction of rail infrastructure charges to the level of marginal cost of maintenance and renewals, i.e. a reduction of mark ups to zero.

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[99] According to IMPRINT-NET (2008), market segments relate to identifiable sets of traffic with similar price elasticity of demand.

[100] Since the analysis of the change in traffic resulting from any change in infrastructure charge will be focused on those countries where new high speed lines are in operation (France, Spain, Germany, Italy and Belgium), this assumption is applicable.

- Secondly, a reduction of current levels of rail infrastructure charges to the optimal level of mark up (as according to section 1.4.2).

6.2.1. Impact on traffic volumes resulting from a reduction of rail infrastructure charges to the level of marginal cost of maintenance and renewals

As presented in chapter 1, Directive 2001/14/EC states that “the charges for the minimum access package and track access to service facilities shall be set at the cost that is directly incurred as a result of operating the train service” (article 7.3), i.e. following the marginal cost principle, even if allowances for applying some mark ups are made.

The characterisation and analysis of the European rail infrastructure charging systems for HSL presented in chapter 4 has proven that the levels of charges implemented for new and upgraded lines are currently set far above the marginal maintenance and renewal costs, which according to the estimations available amount approximately 2 €/train-km (see section 1.4.2). Therefore, it would be interesting to quantify the impact that a reduction of rail infrastructure charges to the level of marginal cost would have on traffic volumes registered on the European high speed lines.

Table 6.1 and **figure 6.3** summarise the impact on traffic volumes resulting from a reduction of rail infrastructure charges to the level of marginal cost of maintenance and renewals (2 €/train-km). According to the results obtained, it can be affirmed that:

- *In France*, if infrastructure charges were reduced to the marginal cost of maintenance and renewals (reductions of about 70%-85%, with the exception of the Paris-Strasbourg link, still a conventional line in the year of the analysis), traffic volumes would increase between 19%-38% in links with new lines. Increases above 30% would be expected to take place in the Paris-Lyons, Paris-Marseilles and Paris-Lille links, which correspond to those already carrying higher volumes of passengers, probably due to the economical importance of the cities they link (especially, Paris and Marseilles) and to their strategic situation in terms of European communication junctions (especially, Lille).

- *In Spain*, a reduction of the level of infrastructure charges to the marginal cost of maintenance and renewals would increase traffic volumes from 21% to 28% for medium and long distance high speed links (with the highest increase in the Barcelona-Seville link, which could be considered as the sum of two different high speed lines) and up to 44% for regional high speed links (Madrid-Toledo).

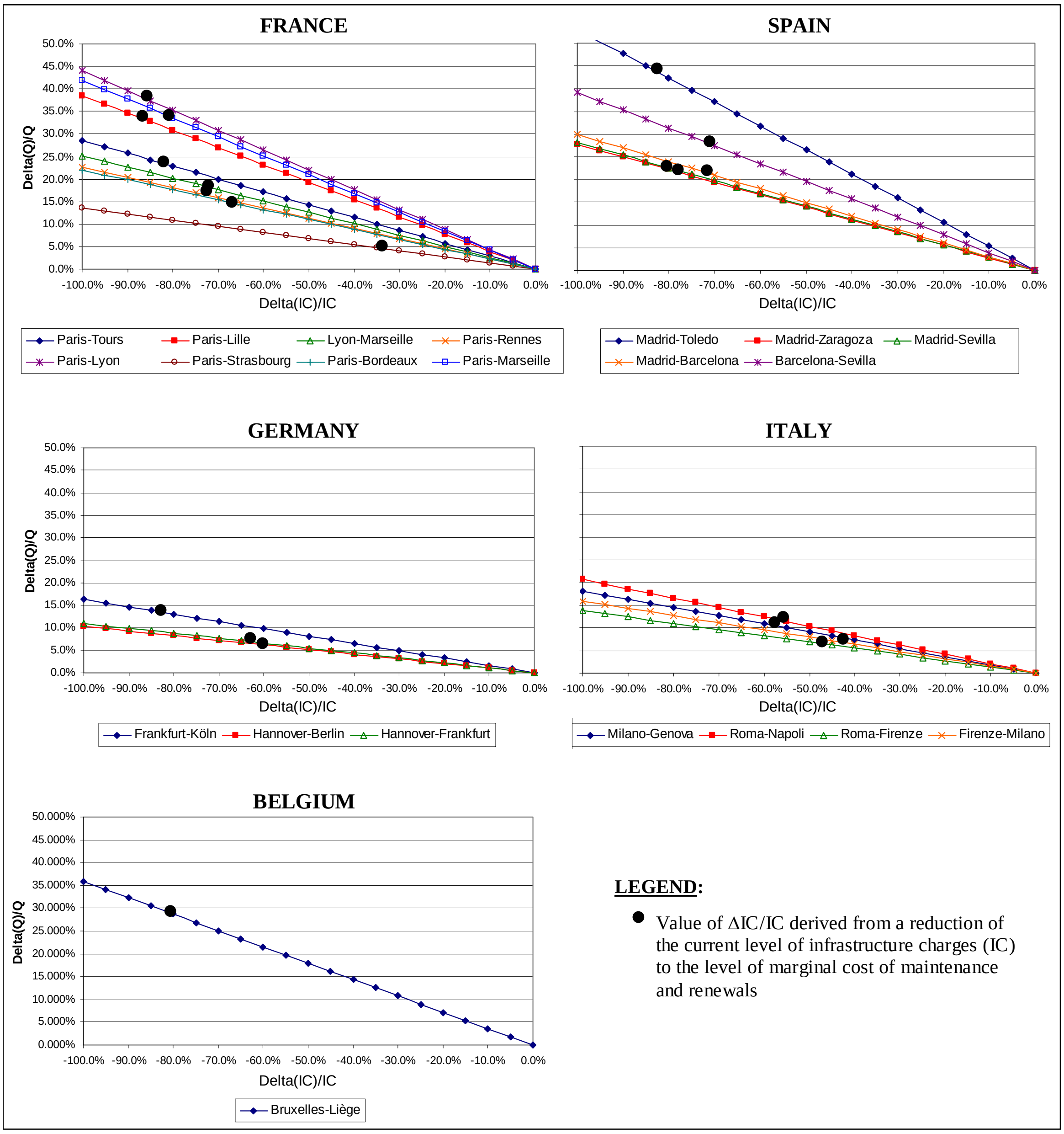
TABLE 6.1 IMPACT ON TRAFFIC VOLUMES RESULTING FROM A REDUCTION OF RAIL INFRASTRUCTURE CHARGES TO THE LEVEL OF MARGINAL COST OF MAINTENANCE AND RENEWALS (2 €/train-km)

Country	Link	Current situation			With reduction (calculated)		
		IC (€/tr-km)	Revenues (€/tr-km)	IC/Rev	ΔIC (€/tr-km)	ΔIC/IC	ΔQ/Q
FR	Paris-Tours	12,1	42,3	28,6%	-10,1	-83,44%	23,84%
	Paris-Lille	15,2	39,4	38,5%	-13,2	-86,82%	33,42%
	Lyon-Marseille	7,6	30,2	25,2%	-5,6	-73,71%	18,57%
	Paris-Rennes	7,7	34,0	22,6%	-5,7	-73,94%	16,68%
	Paris-Lyon	14,6	33,0	44,1%	-12,6	-86,26%	38,00%
	Paris-Strasbourg	3,1	22,4	13,6%	-1,1	-34,60%	4,72%
	Paris-Bordeaux	6,1	27,6	22,0%	-4,1	-67,08%	14,76%
	Paris-Marseille	10,3	24,6	41,9%	-8,3	-80,59%	33,79%
ES	Madrid-Toledo	11,9	22,5	52,9%	-9,9	-83,20%	44,04%
	Madrid-Zaragoza	9,3	33,5	27,8%	-7,3	-78,49%	21,78%
	Madrid-Sevilla	10,2	36,1	28,2%	-8,2	-80,37%	22,67%
	Madrid-Barcelona	7,2	24,0	29,9%	-5,2	-72,19%	21,60%
	Barcelona-Sevilla	7,1	18,2	39,2%	-5,1	-71,94%	28,20%
DE	Frankfurt-Köln	12,1	74,5	16,3%	-10,1	-83,52%	13,61%
	Hannover-Berlin	5,1	49,6	10,3%	-3,1	-60,94%	6,29%
	Hannover-Frankfurt	5,7	51,7	11,0%	-3,7	-64,70%	7,09%
IT	Milano-Genova	4,7	26,0	18,2%	-2,7	-57,62%	10,48%
	Roma-Napoli	4,5	21,9	20,7%	-2,5	-55,86%	11,56%
	Roma-Firenze	3,8	27,5	13,8%	-1,8	-47,23%	6,51%
	Firenze-Milano	3,6	22,3	15,9%	-1,6	-43,68%	6,95%
BE	Bruxelles-Liège	10,5	29,4	35,8%	-8,5	-81,00%	29,03%

Remarks:

- ΔIC corresponds to the decrease in infrastructure charges necessary to reach the marginal cost of maintenance and renewal (i.e. ΔIC = IC – $MC_{maintenance\&renewals}$), accepted to be 2 €/train-km for high speed lines (see table 1.13).
- The calculations of infrastructure charges are those for high speed runs taking place in 2006, departing at 8 a.m. from the origin point and heading for the destination point (for those pricing systems considering the timetable period for the calculation of infrastructure charges) and without taking into account intermediate stops in order to ease the calculations.
- Revenues are calculated as the product of the vehicle capacity, the load factor and the ticket fare. For the train revenues calculation it was assumed a ticket fare equivalent to the 2nd class fare reduced of 25% in order to take into account the considerable season tickets, offers, etc. available, and therefore, to obtain a value for revenues which is close to real RUs' revenues. The vehicle capacity considered was 500 seats (TGV Duplex) and the load factor, 65%.
- Since infrastructure charges calculations correspond to high speed runs departing at 8 a.m. from the origin point and in order not to overestimate the impact on traffic volumes of a variation in rail infrastructure charges, the value of fare elasticity used for the calculations was the one for business trips published by Wardman (1998), that is -0.50 and not -0.7, which is the value given by Crozet (2007) for high speed trains on the Lyons-Paris line.

FIGURE 6.3 CHANGE IN TRAFFIC VOLUMES RESULTING FROM A REDUCTION OF RAIL INFRASTRUCTURE CHARGES



- *In Germany*, the increase in traffic resulting from a reduction of the level of charges to the marginal cost of maintenance and renewals would amount to 14% in links with new lines over their total length (case of Frankfurt-Cologne link) and approximately 7% in links with a mixture of new and upgraded lines (e.g. Hanover-Berlin and Hanover-Frankfurt).

- *In Italy*, if infrastructure charges were reduced to the marginal cost of maintenance and renewals, traffic would experience a 6%-12% increase. In this case, higher increases in traffic would not correspond to new high speed lines. The Italian charging system does not aim at recovering investment costs, thus high speed lines are neither the ones bearing higher infrastructure charges nor higher infrastructure charges-to-revenues ratios (see chapters 4 and 5).

- *In Belgium*, increases in traffic resulting from a reduction of infrastructure charges to the marginal cost of maintenance and renewals would be in line with the increases observed in France. Specifically, they would be expected to amount around 30%.

The preceding conclusions allow affirming that the increases in traffic volumes deduced from f. 6.1 are very significant (even if according to the assumption made, they are supposed to correspond to the minimum change expected). Indeed, transporting up to approximately 40% more passengers in a link such as Paris-Lyons, where approximately 100 trains run daily (including both directions), would in all likelihood be prone to lead to capacity problems. Consequently, in such cases, it may be appropriate to maintain the level of infrastructure charges above the marginal costs of maintenance and renewals, so as to ensure that the current capacity of the existing lines is sufficient to bear the increases in traffic resulting from a reduction of infrastructure charges. Indeed, a state of shortage of capacity could be reached as a consequence of the increase in traffic volumes derived from such an important reduction in the level of infrastructure charges. Consequently, the marginal costs would increase and the reduction in infrastructure charges needed for lowering them until the level of marginal costs would be lower. But in many cases the suggested increase in traffic could be accommodated on the existing infrastructure.

6.2.2. Impact on traffic volumes resulting from a reduction of rail infrastructure charges to the optimal level of mark ups

Assuming that there is generally considered to be a shadow price attached to public funds of around 1,3 (official value in France according to Crozet, 2007), this generally justifies a mark up, depending on the price elasticity of demand for the service in question. Given that infrastructure charges are only a part of the total cost of providing a high speed rail service, substantial mark ups may be justified, as has been demonstrated in chapter 1. However, according to the analysis carried out in chapter 4, in many cases it appears that mark ups even exceed these levels.

In this section calculations are made of the impact of reducing mark ups to the optimal level, which is assumed to be around three times the marginal cost for the main national

European high speed links. These are made considering a price elasticity of traffic equal to -0,70 (see section 1.4.2.3).

The impact on traffic volumes in the main national European high speed links resulting from such a reduction according to the preceding assumptions would be the one presented in **table 6.2**.

TABLE 6.2 IMPACT ON TRAFFIC VOLUMES RESULTING FROM A REDUCTION OF RAIL INFRASTRUCTURE CHARGES TO THE OPTIMAL LEVEL OF MARK UP (APPROXIMATELY THREE TIMES THE MARGINAL COST OF 2 €/TRAIN-KM)

Country	Link	Current situation			With reduction (calculated)		
		IC (€/tr-km)	Revenues (€/tr-km)	IC/Rev	ΔIC (€/tr-km)	ΔIC/IC	ΔQ/Q
FR	Paris-Lyon	14,6	33,0	44,1%	-8.6	-58,78%	60,42%
ES	Madrid-Sevilla	10,2	36,1	28,2%	-4.2	-41,11%	27,05%
DE	Frankfurt-Köln	12,1	74,5	16,3%	-6.1	-50,55%	19,22%
IT	Roma-Firenze	3,8	27,5	13,8%	+2.2	58,32%	-18,76%
BE	Bruxelles-Liège	10,5	29,4	35,8%	-4.5	-43,00%	35,96%

Remarks:

- ΔIC corresponds to the reduction in infrastructure charges necessary to reach the optimal mark up, accepted to be about 3 times the marginal cost.
- See remarks in **table 6.1** for calculations of infrastructure charges and revenues.
- Price elasticity of demand: -0,70 (Crozet, 2007), in order to be consistent with the price elasticity used for calculating the optimal mark up.

Apart from the Italian case, where the charging system does not cover maintenance and renewal costs, infrastructure charges would be reduced by about 40-50% and even up to approximately 60% in the case of the Paris-Lyons link, resulting in traffic volumes increases of 20% to 30% in the Frankfurt-Cologne and Madrid-Seville links, respectively, of about 36% in the Brussels-Liège link and more than 60% in the Paris-Lyons link. As noted above the author has serious doubts about the Paris-Lyons link being able to cope with 60% traffic increase (derived from a reduction of the current level of infrastrucutre charges to the optimal level of mark up) if left with the current capacity.

6.2.3. Comments on the impact that a reduction in rail infrastructure charges equivalent to reducing mark ups either to zero or to the optimal Ramsey mark up may have on traffic volumes

According to the quantification of the impacts resulting from a reduction in rail infrastructure charges equivalent either to reducing mark ups to zero or to equalling infrastructure charges to the optimal Ramsey mark up values, the following statements can be made:

- *It would seem that charging high speed lines with only the marginal cost is not the optimal solution*: Firstly, because the increases in traffic forecasted as a result of such a reduction could result in insufficient infrastructure capacity and the ensuing raise in marginal congestion and scarcity costs would result in the estimates of marginal costs used for the calculations not being appropriate anymore; secondly, it would mean neglecting the high ability to pay that railway operators offering high speed services on high speed lines seem to have, thus losing an important source of revenues for recovering part of the total infrastructure costs; finally, it would also mean neglecting the opportunity cost of public funds, that is, the existence of budget constraints.

- *If mark ups to marginal cost were fixed at the optimal level of mark up* calculated for the main national European high speed links, *traffic volumes would increase approximately by 20-30%, or even 60% in the Paris-Lyons link.*

Hence, the results show that an important percentage of passengers would be deterred from using high speed railways (at least during peak periods) as a result of the influence that the current levels of mark ups exert on the ticket fares, which correspond to the final price to consumers (users).

These impacts can be translated into yearly losses in passengers travelling at peak periods, assuming 5 working days per week and considering that a year has 53 weeks (see **tables 6.3** and **6.4**).

In the French case, where high speed traffic is very intense at peak periods (from 12 to 25 trains during the peak period –5h30 in total–), the estimated yearly increases at the peak period resulting from a reduction of rail infrastructure charges to the level of the marginal cost of maintenance and renewals amount to 490.890 passengers in the Paris-Lyons link, and almost 690.800 passengers in the Paris-Lille link. In Spain, where high speed traffic is considerably lower than in France, the yearly increases at the peak period would accordingly range from 150.000 to 265.000 passengers per year. The lower increases in the Italian network are mainly due to the fact that the peak period only lasts 3 hours, compared to the 5h30 and 5h in the French and the Spanish networks, respectively.

TABLE 6.3 YEARLY IMPACTS (EXPRESSED IN PASSENGERS PER YEAR IN PEAK PERIODS) IN TRAFFIC VOLUMES RESULTING FROM A REDUCTION IN INFRASTRUCTURE CHARGES DOWN TO THE LEVEL OF MARGINAL COST

Country (1)	Peak period	Link(2)	Trains in peak period(3)	ΔQ/Q (IC_{MC})(4)	ΔQ(5) (in pax. per year)
FR	6:30 to 9:00 17:00 to 20:00	Paris-Tours	25	23,84%	513.265
		Paris-Lille	24	33,42%	690.796
		Lyon-Marseille	13	18,57%	207.897
		Paris-Rennes	12	16,68%	172.407
		Paris-Lyon	15	38,00%	490.890
ES	7:00 to 9:29 18:00 to 20:29	Madrid-Toledo	7	44,04%	265.511
		Madrid-Zaragoza	8	21,78%	150.082
		Madrid-Sevilla	8	22,67%	156.174
IT	6:00 to 9:00	Milano-Genova	7	10,48%	63.162
		Roma-Napoli	9	11,56%	168.842
		Roma-Firenze	6	6,51%	33.638
		Firenze-Milano	1	6,95%	5.988

Remarks:

(1) Only countries that consider peak periods have been analysed with the exception of Belgium, since in this country the definition of time periods varies with the line and the running direction.
(2) Only links shorter than 500 km have been considered, because for longer links the journey is almost twice the peak period and, therefore, journeys take place within different time periods.
(3) Trains currently running during peak periods, both directions included. Calculated from Cook (2005) and assuming that departures and arrivals taking place within a 30-minutes margin outside the peak period are considered as trains in peak period.
(4) Impact on traffic volumes resulting from a reduction of the level of charges to the marginal cost of wear and tear (2 €/train-km), assuming a price elasticity of demand of -0,50.
(5) Assuming 265 working days per year (5 working days x 53 weeks/year).

The impact of reducing the level of rail infrastructure charges to the optimal level of mark up would as well be important (see **table 6.4**)[101].

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[101] For the Italian case, to equal the current level of charges to the calculated optimal level of mark ups would imply to increase the current level of infrastructure charges. Therefore, in this case, a loss of passengers would be registered.

TABLE 6.4 **YEARLY IMPACTS (EXPRESSED IN PASSENGERS PER YEAR IN PEAK PERIODS) IN TRAFFIC VOLUMES RESULTING FROM A REDUCTION IN INFRASTRUCTURE CHARGES DOWN TO THE LEVEL OF THE OPTIMAL MARK UP**

Country (1)	Peak period	Link(2)	Trains in peak period(3)	ΔQ/Q (IC$_{Op.M.U}$). (4)	ΔQ(5) (in pax. per year)
FR	6:30 to 9:00 17:00 to 20:00	Paris-Lyon	15	60,42%	780.551
ES	7:00 to 9:29 18:00 to 20:29	Madrid-Sevilla	8	27,05%	186.375
IT	6:00 to 9:00	Roma-Firenze	6	-18,76%	-96.942

Remarks:

(1) Only countries that consider peak periods have been analysed, with the exception of Belgium, since in this country the definition of time periods varies with the line and the running direction.

(2) Only links shorter than 500 km have been considered, because for longer links the journey is almost twice the peak period and, therefore, journeys take place within different time periods.

(3) Trains currently running during peak periods, both directions included. Calculated from Cook (2005) and assuming that departures and arrivals taking place within a 30-minutes margin outside the peak period are considered as trains in peak period.

(4) Impact on traffic volumes resulting from a reduction of the level of charges to the optimal level of mark up (6 €/train-km approx), assuming a price elasticity of demand of -0,70 (Crozet, 2007), in order to be consistent with the price elasticity used for calculating the optimal mark up.

(5) Assuming 265 working days per year (5 working days x 53 weeks/year).

TABLE 6.5 **EVOLUTION OF THE INFRASTRUCTURE CHARGES IN SOME HIGH SPEED LINKS (2001-2008)**
Source: Own from data from Muñoz (2008)

	Links analysed							
Year	**Paris-Lyon**		**Madrid-Sevilla**		**Frankfurt-Köln**		**Roma-Firenze**	
	€	€/train-km	€	€/train-km	€	€/train-km	€	€/train-km
2001	6.419,75	14,83						
2002	6.280,57	14,50						
2003	6.246,77	14,43	3.720,41	7,90	2.141,41	11,90	959,17	3,67
2004	6.295,13	14,54	3.720,41	7,90	2.147,65	11,93	972,60	3,73
2005	6.566,68	15,17	4.650,85	9,87	2.167,01	12,04	989,13	3,79
2006	6.048,42	13,97	4.650,85	9,87	2.148,74	11,94	989,13	3,79
2007	6.364,12	14,70	4.650,85	9,87	2.057,87	11,43	986,40	3,78
2008	6.626,18	15,30	4.650,85	9,87	2.107,35	11,71	986,40	3,78

Remarks:

- The values presented correspond to the average between infrastructure charges for departures taking place at 8 a.m. from both O and D.
- Charges for the Frankfurt-Köln link do not include the charges for the use of stations.
- See chapter 3 for calculation hypotheses.

It is of special interest to mention that even though the calculations were made for the charging systems valid for 2006, the conclusions also apply to 2007 and 2008. Indeed, the analysis of the evolution of the level of rail infrastructure charges for European high speed links presented in annex A10 shows that the level of infrastructure charges for high speed links has remained fairly invariable (see **table 6.5** and **figure 6.4**), France being the country where the variability is the highest. Furthermore, **table 6.6** shows that it can as well be affirmed that the values of the infrastructure charges-to-revenues ratio, essential for determining the impact on traffic volumes of a variation in rail infrastructure charges, have not changed much in the last years. Therefore, the impact on traffic volumes of the pricing systems valid for the year 2007 and 2008 is in the same order of magnitude as the one presented for the year 2006 for the European high speed network.

FIGURE 6.4 EVOLUTION OF THE INFRASTRUCTURE CHARGES IN SOME HIGH SPEED LINKS (2003-2008)

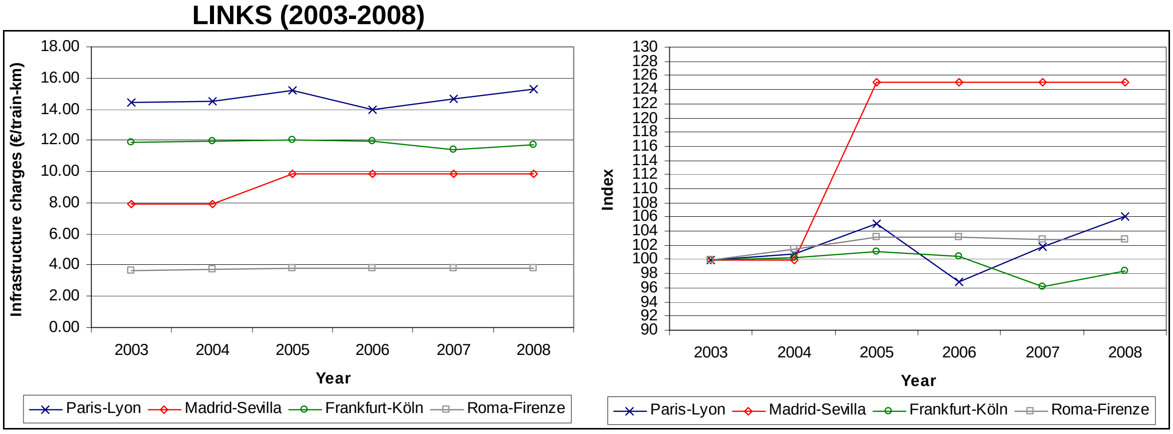

TABLE 6.6 INFRASTRUCTURE CHARGES-TO-REVENUES RATIO (*a*) FOR SOME HIGH SPEED LINES IN 2006 AND 2007

Country	Link	a = IC/Rev	
		Year 2006	Year 2007
France	Paris – Lyon	44,1 %	45,39 %
Spain	Madrid – Sevilla	28,2 %	25,62 %
Germany	Frankfurt – Köln	16,3 %	14,59 %
Italy	Roma – Firenze	13,8 %	12,26 %

6.3. ANALYSIS OF THE POSSIBLE IMPACTS ON THE MODE SPLIT RESULTING FROM A REDUCTION IN INFRASTRUCTURE CHARGES

The analysis of the possible effects on the mode split resulting from a reduction in infrastructure charges has been carried out on the basis of the assumptions presented in section 3.7, relative, on the one hand, to the establishment of a link between rail infrastructure charges and rail ticket fares and, on the other hand, the definition of a market share model for European high speed links.

The assessment has been done in eleven links of the European countries with high speed lines in operation and where high speed railways compete with airways, namely six French links (Lyons–Marseilles, Paris–Rennes, Paris–Lyons, Paris–Strasbourg, Paris–Bordeaux and Paris–Marseilles), two Spanish links (Madrid–Seville and Madrid–Barcelona), two German links (Frankfurt–Cologne and Hanover–Frankfurt), and one Italian link (Rome–Florence).

TABLE 6.7 AVERAGE FARE AND AVERAGE ACCESS COST. LINKS FOR MODEL VALIDATION

Route	Average fare (€)		Access cost (€)	
	Rail	Air	Rail	Air
Lyon - Marseille	32,33	78,87(*)	10	15
Paris - Rennes	37,65	115,28(*)	10	15
Paris - Lyon	44,03	123,34	10	15
Paris - Strasbourg	34,65	138,42	10	15
Paris - Bordeaux	47,78	103,70(*)	10	15
Paris - Marseille	56,4	107,47(*)	10	15
Madrid - Sevilla	52,35	165,9	5	10
Madrid - Barcelona	47,25	49,4	5	10
Frankfurt - Köln	41,3	72	5	10
Hannover - Frankfurt	53,25	113,56	5	10
Roma - Firenze	22,08	107,16	10	10

Remarks:

(*) Air ticket fares to which a factor of 1,8 has been applied in order to bring the fares found closer to the average ticket fare (see assumptions in section 3.7.2.5).

For these links, the average fare and average access cost, the schedule related factors and the access time, as well as the quality factor scores are presented in **tables 6.7**, **6.8** and **6.9**, respectively, following the same assumptions as the ones presented in section 3.7.2.5 for the links used for validating the market share model.

TABLE 6.8 SCHEDULE RELATED FACTORS AND ACCESS TIME

Route	In-vehicle time (min)		Trains/ flights per day		Min freq. Penalty (min)		Check-in time (min)		Access time (min)	
	R	A	R	A	R	A	R	A	R	A
Lyon - Marseille	107	60	9	7	55	59	0	50	30	45
Paris - Rennes	135	65	33	9	20	55	0	50	30	45
Paris - Lyon	115	65	33	27	20	24	0	50	30	45
Paris - Strasbourg	284	60	17	19	38	29	0	50	30	45
Paris - Bordeaux	191	70	19	43	29	17	0	50	30	45
Paris - Marseille	183	65	24	45	25	18	0	50	30	45
Madrid - Sevilla	140	60	22	13	26	38	5	45	30	45
Madrid - Barcelona	305	75	7	64	59	15	5	30	30	30
Frankfurt - Köln	72	45	32	4	20	108	0	45	30	45
Hannover - Frankfurt	139	55	24	10	25	54	0	45	30	45
Roma - Firenze	96	65	29	6	22	75	0	45	30	30

Remarks: R stands for railways and A for airways.

TABLE 6.9 QUALITY FACTOR SCORES (10 IS BEST)

Route	Reliability		Airport links		Price variability		Service quality		Scores	
	R	A	R	A	R	A	R	A	R	A
Lyon - Marseille	6	5	2	10	5	5	7	3	**20**	**23**
Paris - Rennes	6	5	2	10	5	5	7	3	**20**	**23**
Paris - Lyon	6	5	2	10	5	5	7	3	**20**	**23**
Paris - Strasbourg	6	5	2	10	5	5	7	3	**20**	**23**
Paris - Bordeaux	6	5	2	10	5	5	7	3	**20**	**23**
Paris - Marseille	6	5	2	10	5	5	7	3	**20**	**23**
Madrid - Sevilla	10	6	0	10	0	5	9	5	**19**	**26**
Madrid - Barcelona	10	6	0	10	0	5	9	5	**19**	**26**
Frankfurt - Köln	9	8	6	10	7	9	6	5	**28**	**32**
Hannover - Frankfurt	9	8	6	10	7	9	6	5	**28**	**32**
Roma - Firenze	9	6	0	10	7	7	7	4	**23**	**27**

Remarks: R stands for railways and A for airways.

With the inputs above, the current charging and market share scenario has the characteristics presented in **table 6.10**.

TABLE 6.10 CHARACTERISATION OF THE CURRENT CHARGING AND MARKET SHARE SCENARIO IN ROUTES SERVED BY HIGH SPEED SERVICES

Links	IC (€/train-km)	F (€)	a=IC/Rev	Market share			V_Air - V_rail
				Real	Model	Differ.	
Lyon-Marseille	7,61	32,33	25,19%		86%		-84
Paris-Rennes	7,67	37,65	22,56%		92%		-115
Paris-Lyon	14,56	44,03	44,05%	92%	91%	1%	-107
Paris-Strasbourg	3,06	34,65	13,64%	60%	66%	-6%	-31
Paris-Bordeaux	6,08	47,78	22,01%	68%	69%	-1%	-38
Paris-Marseille	10,30	56,40	41,93%	69%	69%	0%	-37
Madrid-Sevilla	10,19	52,35	28,20%	92%	93%	-1%	-118
Madrid-Barcelona	7,19	47,25	29,92%	12%	5%	7%	140
Frankfurt-Köln	12,13	41,25	16,29%	97%	98%	-1%	-173
Hannover-Frankfurt	5,66	53,25	10,96%		85%		-81
Roma-Firenze	3,79	22,08	13,78%		96%		-150

Remarks:
- IC: Rail infrastructure charges
- F: Rail ticket fares
- a: rail infrastructure charges-to-rail revenues from ticket sales ratio
- Differ.: Difference between the real market share and the one predicted by the market share model
- V_Air – V_Rail: Difference between air and rail utilities

The next sections present how the current mode split would change under two scenarios with rail infrastructure charges:

- Reduced to the level of marginal cost of maintenance and renewals, i.e. a reduction of mark ups to zero.

- Reduced to the optimal level of mark up.

Before presenting the results, it is important to point out that:

- The charges-to-revenues ratios (*a*) used for the calculations correspond to average ratios except for those countries where rail infrastructure charging systems differentiate by time of day (peak, normal and off-peak periods): France, Spain, Italy and Belgium. In these countries, the ratio *a* is slightly higher than the average as a result of the assumptions on rail infrastructure charges calculations presented in **table 3.7**. According to these assumptions, charges are calculated for trains departing at 8 a.m., that is, departing at the peak period. This implies that at least the first 1h-1h30' of the journey takes place during peak period, when the highest levels of charges are applied.

- It has been assumed that the rail market share values available are not only representative for the link in its whole, but they are also representative of the mode split observed in the morning peak. This assumption may slightly underestimate the market share really observed in links for the morning period.

- Only modal shift has been quantified. No consideration has been taken of the possibility of a reduction of the level of rail infrastructure charges inducing new traffic.

6.3.1. Impact on mode split resulting from a reduction of rail infrastructure charges to the level of marginal cost of maintenance and renewals

Table 6.11 presents the utilities expected from a reduction of rail infrastructure charges to the level of marginal cost of maintenance and renewals, while **table 6.12** summarises the impacts on mode split resulting from such utilities, according to f. 3.34 and f. 3.35. Those impacts, which translate into 0 to 19 points more in the market share, are analysed and commented in section 6.3.3.

TABLE 6.11 UTILITIES RESULTING FROM REDUCING THE CURRENT LEVEL OF RAIL CHARGES TO THE MARGINAL COST OF WEAR AND TEAR (2 €/TRAIN-KM)

Route	ΔIC/IC	ΔF/F		New F (€)		V_Rail		V_Air - V_rail	
		ε=-0,5	ε =-0,7	ε =-0,5	ε =-0,7	ε =-0,5	ε =-0,7	ε =-0,5	ε =-0,7
Lyon-Marseille	-74%	-37%	-62%	20,32	12,32	-115	-107	-95,82	-103,8
Paris-Rennes	-74%	-33%	-56%	25,09	16,71	-112,5	-104,1	-128	-136,3
Paris-Lyon	-86%	-76%	-127%	10,57	0,00(1)	-86,94	-76,38	-140	-150,6
Paris-Strasbourg	-35%	-9%	-16%	31,38	29,20	-207,4	-205,2	-34,48	-36,66
Paris-Bordeaux	-67%	-30%	-49%	33,67	24,26	-155,6	-146,2	-52,38	-61,78
Paris-Marseille	-81%	-68%	-113%	18,28	0,00(1)	-133,9	-115,6	-75,2	-93,48
Madrid-Sevilla	-80%	-45%	-76%	28,62	12,80	-121,2	-105,4	-141,8	-157,6

Route	ΔIC/IC	ΔF/F		New F (€)		V_Rail		V_Air - V_rail	
		ε=-0,5	ε =-0,7	ε =-0,5	ε =-0,7	ε =-0,5	ε =-0,7	ε =-0,5	ε =-0,7
Madrid-Barcelona	-72%	-43%	-72%	26,84	13,23	-240,1	-226,5	119,1	105,5
Frankfurt-Köln	-84%	-27%	-45%	30,02	22,54	-69,55	-62,07	-184,6	-192,1
Hannover-Frankfurt	-65%	-14%	-24%	45,70	40,67	-124,1	-119	-88,07	-93,11
Roma-Firenze	-47%	-13%	-22%	19,21	17,29	-82,76	-80,84	-152,5	-154,4

Remarks:

(1) The new ticket fares calculated have negative values. Since that would not make sense, they have been equalled to zero.

TABLE 6.12 CHANGES IN MODE SPLIT RESULTING FROM REDUCING THE CURRENT LEVEL OF RAIL CHARGES TO THE MARGINAL COST OF WEAR AND TEAR (2 €/TRAIN-KM)

Route	Market share new scenario		ΔMarket share(1)	
	ε=-0,5	ε =-0,7	ε =-0,5	ε =-0,7
Lyon-Marseille	89%	90%	2,86%	4,48%
Paris-Rennes	94%	95%	1,73%	2,67%
Paris-Lyon	95%	96%	4,52%	5,45%
Paris-Strasbourg	68%	69%	1,55%	2,56%
Paris-Bordeaux	75%	79%	6,02%	9,55%
Paris-Marseille	83%	88%	14,47%	19,23%
Madrid-Sevilla	95%	97%	2,81%	4,09%
Madrid-Barcelona	7%	9%	2,44%	4,66%
Frankfurt-Köln	98%	98%	0,50%	0,78%
Hannover-Frankfurt	87%	88%	1,96%	3,15%
Roma-Firenze	96%	96%	0,22%	0,37%

Remarks:

(1) Difference in market share based on the predictions of the market share model for both the initial and the final scenarios.

6.3.2. Impact on mode split resulting from a reduction of rail infrastructure charges to the optimal level of mark ups

In order to assess the impact on mode split resulting from a reduction of rail infrastructure charges to the optimal level of mark ups, the utilities expected from such a reduction have been calculated (see **table 6.13**). The impacts on mode split resulting from such utilities are summarised in **table 6.14**. Those impacts, which translate into 0 to 13 points more in the market share, are analysed and commented in section 6.3.3.

TABLE 6.13 UTILITIES RESULTING FROM REDUCING THE CURRENT LEVEL OF RAIL CHARGES TO THE OPTIMAL MARK UP

Route	ΔIC/IC	ΔF/F		New F (€)		V_Rail		V_Air - V_rail	
		ε=-0,5	ε =-0,7	ε =-0,5	ε =-0,7	ε =-0,5	ε =-0,7	ε =-0,5	ε =-0,7
Lyon-Marseille	-21%	-11%	-18%	28,88	26,59	-123,6	-121,3	-87,25	-89,55
Paris-Rennes	-22%	-10%	-16%	33,94	31,47	-121,3	-118,8	-119,1	-121,6
Paris-Lyon	-59%	-52%	-86%	21,23	6,03	-97,6	-82,4	-129,3	-144,5
Paris-Strasbourg	96%	26%	44%	43,74	49,80	-219,8	-225,8	-22,12	-16,06
Paris-Bordeaux	-1%	-1%	-1%	47,51	47,34	-169,5	-169,3	-38,53	-38,71
Paris-Marseille	-42%	-35%	-58%	36,64	23,47	-152,2	-139	-56,84	-70,01
Madrid-Sevilla	-41%	-23%	-39%	40,21	32,12	-132,8	-124,7	-130,2	-138,3
Madrid-Barcelona	-17%	-10%	-17%	42,57	39,45	-255,8	-252,7	134,8	131,7
Frankfurt-Köln	-51%	-16%	-27%	34,45	29,92	-73,98	-69,45	-180,2	-184,7
Hannover-Frankfurt	6%	1%	2%	53,94	54,40	-132,3	-132,8	-79,84	-79,38
Roma-Firenze	58%	16%	27%	25,63	28,00	-89,18	-91,55	-146	-143,7

TABLE 6.14 CHANGES IN MODE SPLIT RESULTING FROM REDUCING THE CURRENT LEVEL OF RAIL CHARGES TO THE OPTIMAL MARK UP

Route	Rail's market share new scenario		ΔMarket share(1)	
	ε=-0,5	ε =-0,7	ε =-0,5	ε =-0,7
Lyon-Marseille	87%	87%	0,88%	1,44%
Paris-Rennes	93%	93%	0,55%	0,90%
Paris-Lyon	94%	96%	3,37%	4,94%
Paris-Strasbourg	62%	59%	-4,49%	-7,59%
Paris-Bordeaux	70%	70%	0,12%	0,20%
Paris-Marseille	77%	82%	8,28%	12,87%
Madrid-Sevilla	94%	95%	1,60%	2,47%
Madrid-Barcelona	5%	6%	0,48%	0,82%
Frankfurt-Köln	98%	98%	0,32%	0,51%
Hannover-Frankfurt	85%	85%	-0,19%	-0,32%
Roma-Firenze	96%	96%	-0,30%	-0,50%

Remarks:

(1) Difference in market share based on the predictions of the market share model for both the initial and the final scenarios.

6.3.3. Comments on the impact that a reduction in infrastructure charges can have on mode split

Figures 6.5 and **6.6** summarise the impact that a reduction in infrastructure charges equivalent to reduce mark ups either to zero or the optimal Ramsey mark up can have on mode split.

According to the results obtained, for those links where the capacity of the line is enough to absorb significant increases of traffic volumes, the increases in traffic derived from reductions in infrastructure charges down to the level of the optimal mark up or lower, are expected to have different impacts on the mode split between railways and airways. Indeed, similar changes in the level of infrastructure charges (e.g. reduction of about 80%-85%) do not cause similar changes in mode split. For instance, with initial market shares of about 70%, a reduction of the rail infrastructure charges of about 80%, gives rise to changes in rail market share comprised between 15 and 19 points (e.g. Paris-Marseilles), while those changes are lower than 1 point for a similar change in infrastructure charges in links with an initial market share of 98% (e.g. Frankfurt-Cologne). Even if the value of the charges-to-revenues ratio was the same for both links, the same conclusion would apply: if the charges-to-revenues ratio of the Frankfurt-Cologne link had a charges-to-revenues ratio equal to the one observed on the Paris-Marseilles link (44,93% instead of the current 16,29%), the change in market share would still be considerably low (1 to 1,5 points) compared to the 15-19 points expected on the French link.

Figures 6.7 and **6.8**, in which the change in market share has been represented as the dependent variable and the change in infrastructure charges (reductions from -100% to 0%[102]) has been represented as the explanatory variable, give more information on the impact on mode split resulting from a reduction in rail infrastructure charges:

- Links for which the rail market share is already very high (higher than 95%), the level of charges does not seem to play an important role in the competitiveness of railways. In other words, for initial market shares higher than 95%, changes in market share derived from a reduction on the level of rail infrastructure charges could be considered negligible, no matter what the level of the reduction in the rail infrastructure charges is. Indeed, reductions in the level of charges of about 50% and 85% (and even 100%) lead to changes in mode split lower than 1 point (see Frankfurt-Cologne and Rome-Florence links in **figures 6.7** and **6.8**).

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[102] Reductions of rail infrastructure charges have been limited to a maximum of 100%. Higher reductions make no sense, since it would imply reducing infrastructure charges to levels lower than charges set at the marginal cost of wear and tear.

- Links for which the rail market share is comprised between 85% and 95% (and the charges-to-revenues ratio ranges from 10% to 44%), the impact on mode split caused by a reduction in infrastructure charges reaches 5,5 points, assuming a maximal reduction of rail infrastructure charges of 100%[103] (see Paris-Rennes, Hanover-Frankfurt, Madrid-Seville, Lyons-Marseilles and Paris-Lyons links in **figures 6.7** and **6.8**).

- For similar initial market shares comprised in the interval 50% - 85%, the value of the charges-to-revenues ratio (*a*) has an important effect on the impact on mode split. Indeed, in the Paris-Strasbourg (*a* = 16,64%) and Paris-Marseilles (*a* = 41,93%) links, which have an initial rail market share of 66% and 69% respectively, a change in the level of rail infrastructure charges (in absolute value) of 96% gives rise to a change in market share lower than 8 points, while the change in rail market share reaches 13 points for the Paris-Marseilles link with half the change in the level of rail infrastructure charges (42% compared to the 96% for the Paris-Strasbourg link).

- For links with initial market shares above 90%, the maximal impact on mode split resulting from a reduction of rail charges seems to be at around 5-5,5 points (assuming $a \leq 40\%$). This impact threshold is reached when reductions on rail infrastructure charges are so that the change in ticket fares result in ticket fares equal to 0 €.

- For links with initial market shares of about 70% the maximal impact on mode split resulting from a reduction of rail charges seems to be at around 17-19 points (assuming $a \leq 40\%$). This impact threshold is reached when reductions on rail infrastructure charges are so that the change in ticket fares result in ticket fares equal to 0 €.

The previous remarks show that the impact on mode split resulting from a reduction of rail infrastructure charges to the level of marginal cost of maintenance and renewals or to the optimal mark up seems to strongly depend on the initial commercial position of high speed railways, with the impact being higher in markets where the railways position can still be improved to a wide extent. This result was to some extent to be expected: on the one hand, because of the S-shaped relation of the logit probability to representative utility; on the other hand, because in the logit model, the point at which the increase in representative utility has the greatest effect on the probability of its being chosen is when

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[103] The higher reductions needed to equal current levels of charges to the marginal cost of maintenance and renewals are of about 85% for the high speed links analysed.

FIGURE 6.5 IMPACT ON RAIL'S MARKET SHARE OF A REDUCTION IN RAIL CHARGES EQUIVALENT TO REDUCE MARK UPS EITHER TO ZERO OR TO THE OPTIMAL RAMSEY MARK UP (ASSUMING ε = -0,50)

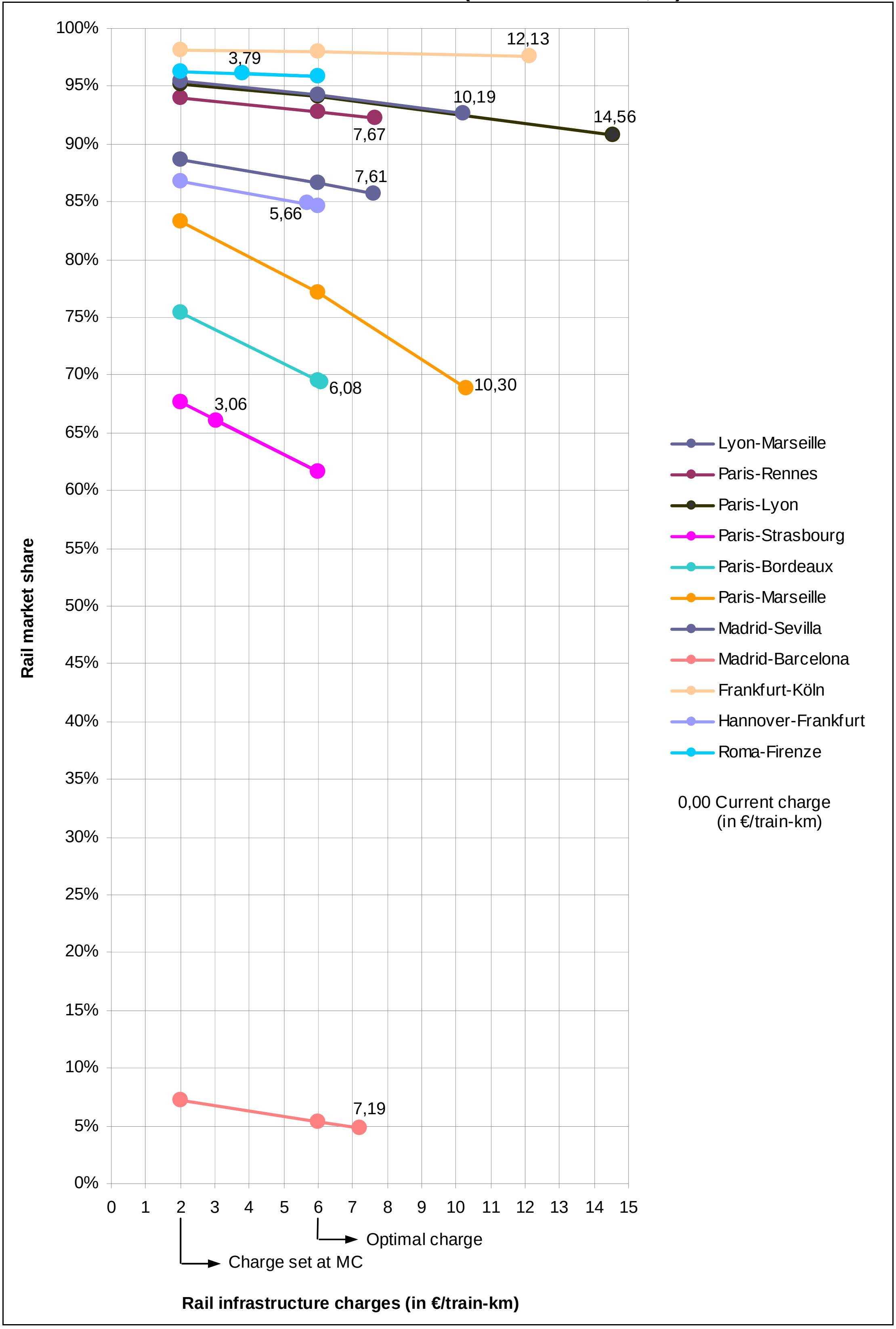


FIGURE 6.6 IMPACT ON RAIL'S MARKET SHARE OF A REDUCTION IN RAIL CHARGES EQUIVALENT TO REDUCE MARK UPS EITHER TO ZERO OR TO THE OPTIMAL RAMSEY MARK UP (ASSUMING ε = -0,70)

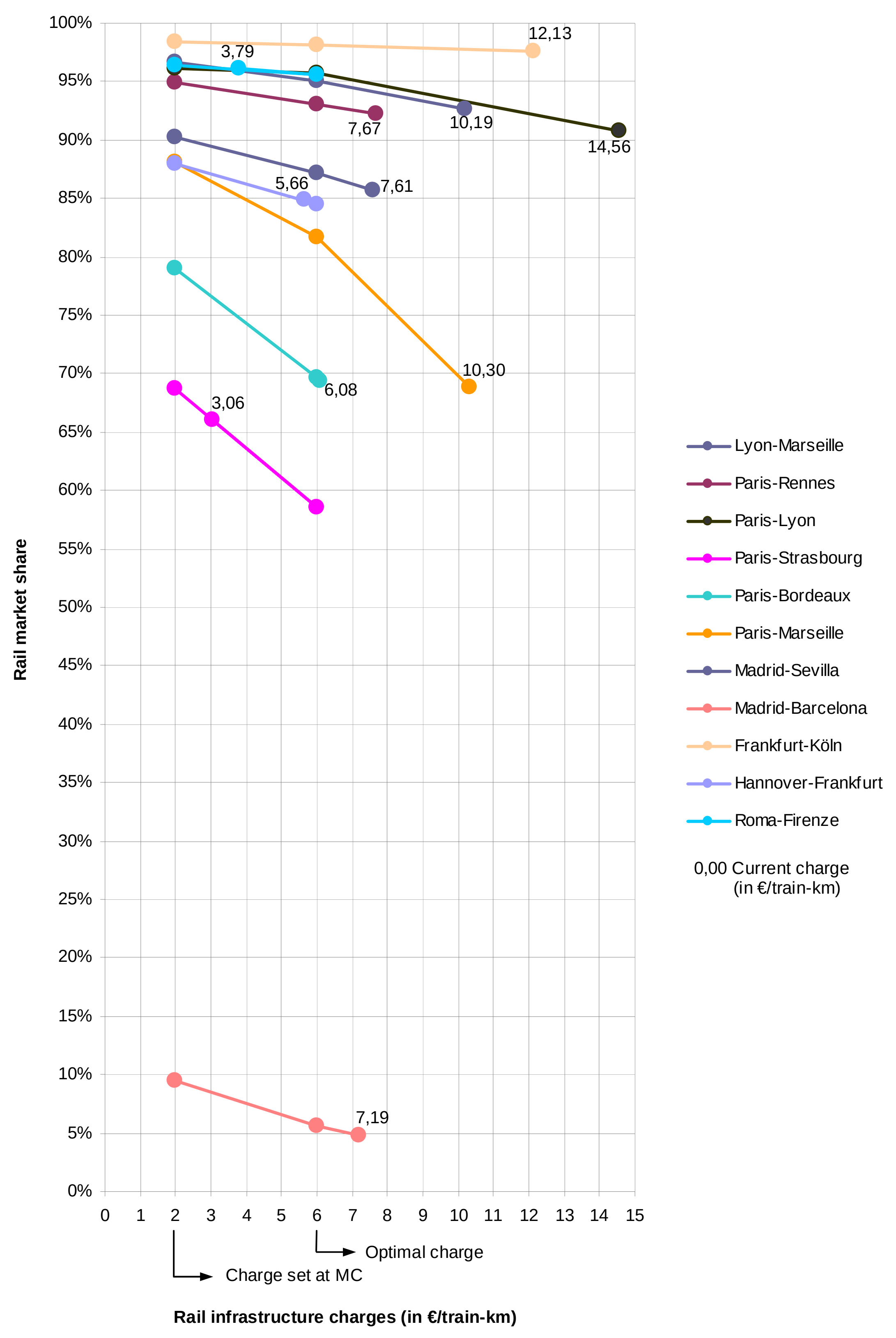
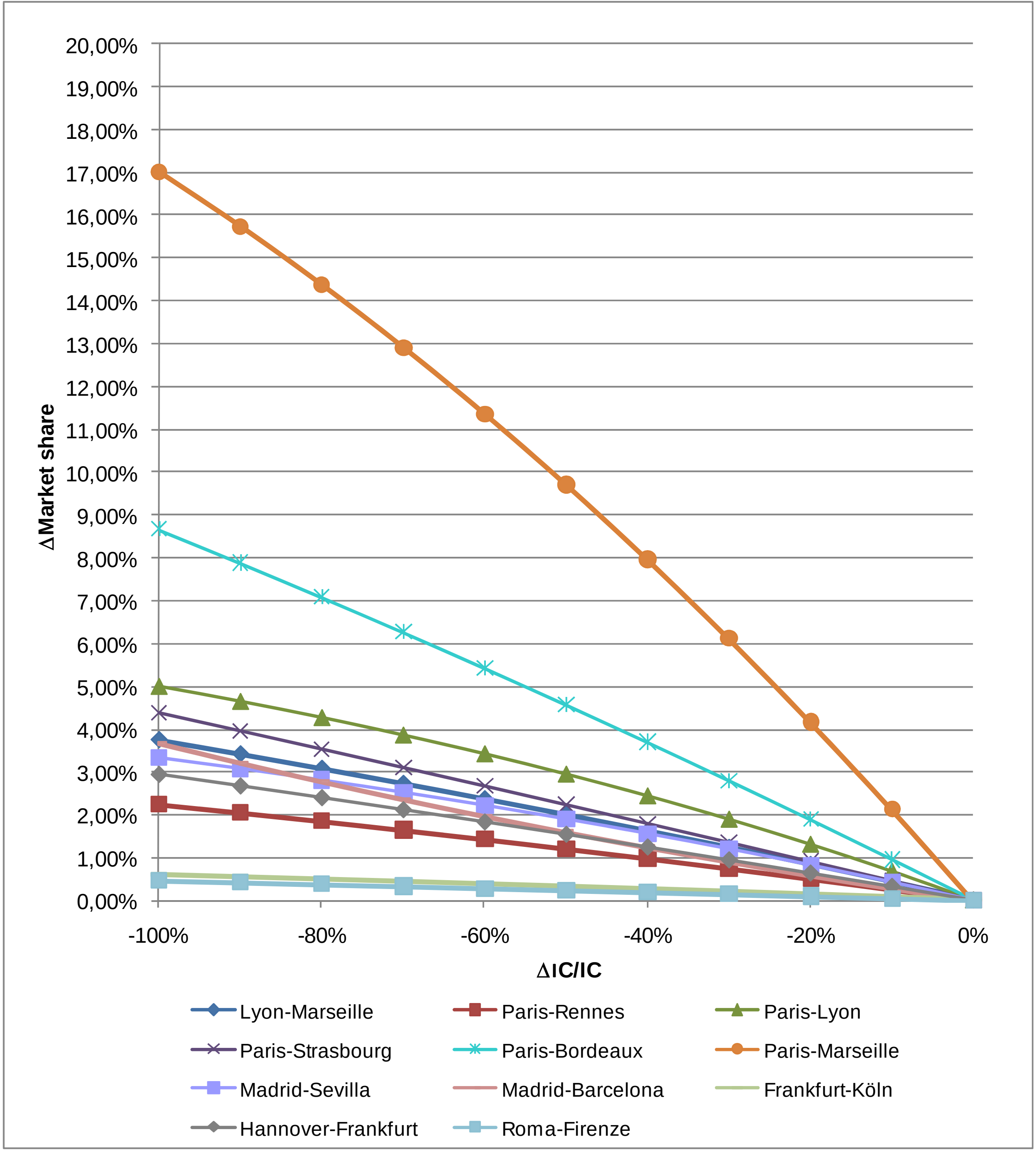
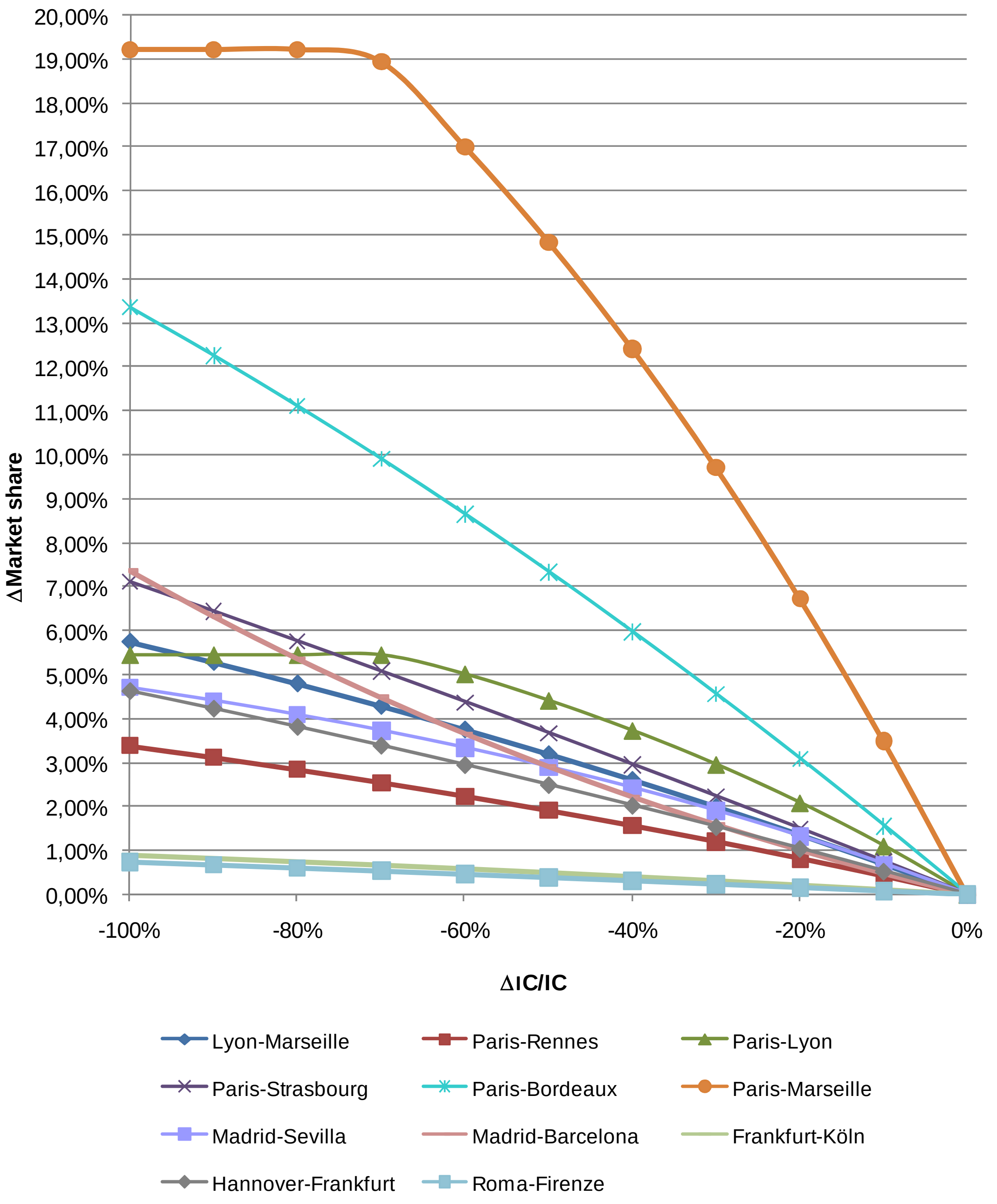


FIGURE 6.7 IMPACT ON RAIL'S MARKET SHARE RESULTING FROM A REDUCTION OF THE LEVEL OF RAIL INFRASTRUCUTRE CHARGES (ASSUMING ε = -0,50)



the probability is close to 0,5, meaning a 50-50 chance of the alternative being chosen, as presented in chapter 3. In addition, taking into consideration the results of chapter 5 (which show that charges-to-revenues ratios are higher for new lines than for conventional lines), it can be affirmed that new high speed lines with initial market shares comprised between 50% - 85% are the links most penalised by the setting of charges above the marginal cost of maintenance and renewals and above the optimal level of mark up.

FIGURE 6.8 IMPACT ON RAIL'S MARKET SHARE RESULTING FROM A REDUCTION OF THE LEVEL OF RAIL INFRASTRUCUTRE CHARGES (ASSUMING ε = -0,70)



Remarks: The impact threshold is reached when reductions on rail infrastructure charges are so that the change in ticket fares result in nil ticket fares.

These results would be showing that even in countries where there seems to be a clear market-based pricing (for instance, France), mark ups would have not been imposed after careful consideration of the most efficient way of doing so and their consequences for the market position of the RU in the market segment in question.

The first high speed lines built in Europe were characterised by optimal distances for high speed runs and, therefore, high rail market shares compared to airways. Contrary to these main links, the high speed links that should complement and allow the connectivity of the European high speed network, do not follow the same patterns and have, consequently, lower rail market shares. Therefore, the optimal use of the future high speed network, which is meant to promote sustainable development by allowing a modal shift from airways to railways, will require taking careful consideration of the level of mark ups above marginal cost applied to the infrastructure charges to be paid by trains running on the high speed network.

CHAPTER 7

CONCLUSIONS AND FURTHER RESEARCH

7.1. SUMMARY AND CONCLUSIONS

The aim of this PhD Thesis was to determine the impacts and, therefore, the consequences that current levels of rail infrastructure charges implemented in the European framework have on the competitiveness of the high speed passenger services that run on the European railway network.

The structure of the PhD Thesis has been designed so that three intermediate sub-objectives could be reached, namely:

- To characterise the order of magnitude of rail infrastructure charges in European high speed lines/services based on the marginal cost, which is the charging principle required by the European legislation.
- To characterise the rail infrastructure charging systems applied to European high speed services/lines, in order to detect whether mark ups above marginal cost of wear and tear are being applied to those services and if so, how they are applied.
- To quantify the impacts on traffic volumes and mode split resulting from bringing the current levels of rail infrastructure charges (applied in the European high speed network) to the level of marginal cost of maintenance and renewals and to the optimal Ramsey mark up.

Those sub-objectives allow answering three different aspects, the knowledge of which is essential for attaining the main objective of this piece of research.

With regard to the first sub-objective, involving the characterisation of the order of magnitude of rail infrastructure charges for European high speed lines/services based on the marginal cost, the two principles allowed by the European legislation were considered: charges based on the principles of short run marginal social cost, and charges based on the same principles but with mark ups where necessary to satisfy financial requirements. To quantify the first one, the different types of marginal costs composing the short run marginal cost (namely marginal infrastructure costs, marginal environmental costs, external marginal costs of accident, and marginal congestion and scarcity costs) were considered. In this regard, while external marginal congestion and scarcity costs and external marginal accident costs can be considered negligible for the European high speed network, there may be environmental costs of a magnitude of about 2 €/train-km. However, since at present air transport does not generally pay these costs, and therefore according to the legislation they should not be added to average rail charges, they were not considered. For the quantification of the second principle, it was assumed that there is generally considered to be a shadow price attached to public funds of around 1,3, and that regarding high speed railways the price elasticity of demand can be considered equal or higher than -0,70 (in absolute terms).

With the abovementioned considerations it can be concluded that:

- *On the best evidence available, short run marginal social cost on high speed lines does not appear to be above 2 €/train-km.*

- *The optimal level of charges based on marginal social costs should not exceed 6,4 €/train-km (given that there is generally considered to be a shadow price attached to public funds of around 1,3 and assuming a price elasticity of demand equal or higher than -0,70 in absolute terms).*

Regarding the second sub-objective, involving the characterisation of the rail infrastructure charging systems applied to European high speed services/lines, in order to detect if mark ups above marginal cost of wear and tear are being applied to those services and if so, how they are applied, conclusions can be grouped into three categories: on the one hand, conclusions resulting from a global analysis of the pricing systems implemented in EU-25 (except for Cyprus and Malta) plus Norway and Switzerland; on the other hand, conclusions comparing the characteristics of the different pricing systems implemented in countries with high speed lines in operation; finally, conclusions on how mark ups above marginal cost are being applied by current European rail pricing systems.

From the analysis of the pricing systems implemented in the European countries, it can be concluded that:

- *The cost categories detected in the 2006 rail pricing systems of the EU-25 framework differ from the ones used for calculating the charges in the EU, which at the same time differ from the cost categories meant to be covered by European rail pricing systems. Those differences show the existing difficulties for quantifying the costs resulting from the use of the infrastructure and allocating them to the running of trains.*

- *The cost category "Mark ups" for the calculation of rail infrastructure charges gathers investment expenditures and financial costs. In the Network Statements, two different cost categories refer exclusively to "Mark ups", namely: "Access" and "Capacity reservation". Both of them are only found in the charging systems of countries with high speed lines in operation (except for Luxembourg, for the first cost category, and the Netherlands and the Slovak Republic for the second one). Consequently, high speed lines in operation are subject to two additional cost categories to which mark ups aimed at increasing the cost recovery of infrastructure charges are exclusively allocated.*

- *There is a widespread tendency to apply higher charges to high speed lines than to the rest, i.e. of applying higher mark ups over marginal costs to high speed lines.*

From the comparison of the characteristics of the different pricing systems implemented in countries with high speed lines in operation, it can be concluded that:

- *Rail infrastructure charging systems implemented in European countries with high speed lines in operation correspond to a second-best charging strategy, either materialised with the application of mark ups to social marginal cost (MC+) or the collection of the full financial cost minus subsidies (FC-).*

- *The charging systems based on the application of mark ups to marginal cost (CM+) have rail access charging based on additive charging components, with a fixed and a variable component, the latter representing more than 80% of the charges.*

- *The charging systems based on the collection of the full financial cost minus subsidies (FC-) have a charging structure with a linear tariff: the rail access charging consists of a base price multiplied by different coefficients.*

- *Major mark ups above marginal costs are applied to high speed lines with the aim of assisting with cost recovery (Italy is the only European country with high speed lines in operation that does neither partially nor totally recover maintenance costs through rail infrastructure charges).*

- *The level of mark ups above marginal cost in high speed lines (HSL) differs from one country to another. This could be due to differences in the level of subsidies in each country (the level of subsidies really allocated to HSL is unknown) as well as to different applications of price discrimination.*

- *Mark ups applied to high speed lines seem to be higher than the optimal value of mark up except for the Italian case, the only one not aiming at recovering investment costs. Indeed, calculations for 2006 and a train supposed to leave at 8 a.m. from the origin point and heading for the destination point (in the pricing systems considering the timetable period for the calculation of infrastructure charges) and without taking into account intermediate stops in order to ease the calculations, show infrastructure charges above 10 €/train-km for the main national links of the countries with high speed lines in operation (with the exception of the Italian link).*

Finally, with the assumptions made on charges calculations, one can come to the following conclusions on how mark ups above marginal cost are being applied by current European rail pricing systems:

- *Ramsey-Boiteux pricing is broadly applied in the countries charging mark ups to social marginal cost, differentiating by broad category of passenger train, location and time of day, although each country using different criteria.*

- *Infrastructure charges for HSL seem to be a mix of recovery of the capital cost with a mark up on what the market could bear. Indeed, mark ups seem to be applied by means of three different common concepts: mark ups based on wear and tear costs, mark ups reflecting investment costs (i.e. set to recover part of investment costs) and mark ups reflecting commercial position (i.e. set at a level that the market can bear, taking into consideration the commercial position of high speed railways).*

- *The mark ups based on marginal cost of wear and tear would be intended to recover part of the higher maintenance expenses for HSL that allow lower levels of marginal cost of wear and tear compared to freight services.*

- *The available data does not allow knowing what proportion of the mark ups relates to what costs. However, the results suggest that where pricing systems are meant to partly cover investment costs, there is a correlation between rail infrastructure charges and the type of infrastructure, according to which the percentage in length of new lines in a link seems to be directly proportional to the amount of charge to be paid by a passenger train for running through a link of the European HS network (i.e. the longer the length of the link with new line, the higher the amount of infrastructure charges).*

- *Mark ups considering the commercial position are only applied to new and* *upgraded infrastructure: current charging systems do not apply any mark up on the ability to pay of railway undertakings (RU) offering passenger services on conventional lines; conversely, infrastructure charges for new high speed lines are very sensitive to an increase of their commercial position (there is a strong correlation between high infrastructure charges and infrastructure with high performance –expressed in terms of commercial speed–).*

- *The consideration of the commercial position of the market by pricing systems may have an important influence on the value of infrastructure charges for HSL: charges for HSL seem to be strongly bound up with the total travel time. Indeed, a reduction of a journey from 2 hours to 1 hour brings for instance mark ups of up to 7 €/train-km in France and 2 €/train-km in Spain.*

The results presented in the preceding points are of great interest, since the research carried out until now had neither related charges to infrastructure characteristics nor studied infrastructure charges for high performance passenger services in detail.

With regard to the third sub-objective, involving the quantification of the impacts on traffic volumes and mode split resulting from bringing the current levels of rail infrastructure charges (applied in the European high speed network) to the level of marginal cost of maintenance and renewals and to the optimal Ramsey mark up, yield the following conrtributions (grouped into three groups): on the one hand, the establishment of a methodology for quantifying the impacts on traffic volumes and mode split of a variation in the level of rail infrastructure charges; on the other hand, the quantification of the impact on traffic volumes of reducing mark ups either to zero, or to the optimal level of charges; finally, the quantification of the impact on mode split of reducing mark ups to the abovementioned levels.

The methodology proposed in this PhD Thesis to quantify the impacts on traffic volumes and mode split of a variation in the level of rail infrastructure charges assumes that the profitability must remain unchanged and that the mode split can be modelled by means of a bimodal logit model. This methodology can be summarised as follows:

- *Determination of the impacts on traffic volumes of a variation in the level of rail infrastructure charges:*

$$\frac{\Delta Q}{Q} = \frac{\varepsilon}{1+\varepsilon} \cdot a \cdot \frac{\Delta IC}{IC} \quad \text{(assuming profitability unchanged: } \Delta Rev = \Delta IC\text{)}$$

where:
- Q is the traffic expressed in passengers per train
- ε is the price elasticity of demand
- *a* is the rail infrastructure charges-to-revenues from ticket sales ratio
- *IC* are the rail infrastructure charges

➢ *Determination of the impacts on mode split of a variation in the level of rail infrastructure charges:*

$$\frac{\Delta F}{F} = \frac{1}{(1+\varepsilon)} \cdot a \cdot \frac{\Delta IC}{IC} \quad \text{(assuming profitability unchanged: } \Delta Rev = \Delta IC\text{)}$$

and

$$p_{ij}^{HS} = \frac{1}{1+e^{0{,}0214 \cdot \left(V_{ij}^{Air} + V_{ij}^{HS}\right)}}$$

with:

$$V_{ij}^{k} = (-VoT) \cdot \left[IV_t + \left(\frac{24 hours}{Freq\_tr\_day} \right)^{7{,}5 \cdot MFP} + 1{,}5 \cdot ChIn_t + 1{,}25 \cdot A_t \right] - \\ - Av.fare - Access.\cos t + Scores$$

where:
- F corresponds to the ticket fare expressed in euros
- ε is the price elasticity of demand
- *a* is the rail infrastructure charges-to-revenues from ticket sales ratio
- *IC* are the rail infrastructure charges
- p_{ij}^{HS} is the high speed railways market share with regard to airways
- V_{ij}^{k} is the utility function for a link *ij* and a mode of transport *k*
- *VoT* is the value of time (33 €/hour, except for the links crossing the Channel Tunnel, for which VoT equals 24,16 €/hour)
- IV_t corresponds to the “in-vehicle time”, that is, the journey time
- *Freq_tr_day* is the frequency expressed as the number of trains (or flights) per day
- *MFP* is the minimum frequency penalty, expressed in minutes
- $ChIn_t$ corresponds to the check-in time plus the terminal exit time (i.e. plus an allowance for time to exit the airport)
- A_t is the access time, defined as the average time required to access the terminals

The analysis carried out with the assumptions made on charges and revenues calculations leads to the following conclusions about the value of the charges-to-revenues ratio *a*:

- *Links with new lines (the ones that respond to the technical definition of HSL) have the highest charges-to-revenues ratios (ratios ranging from 25% to 40% for links with new high speed lines at least along 40% of the total length of the link).*

- *It would seem that the value of the charges-to-revenues ratio tends to increase with faster commercial speeds, following the same tendency observed between rail infrastructure charges and the commercial speed.*

- *While no correlation can be established between the value of rail charges-to-revenues ratio and the commercial speed for conventional lines, the correlation between these two parameters is very strong for links constituted by new infrastructure (new lines). However, the type of infrastructure does not allow establishing a clear correlation between the charges-to-revenues ratio and the travel time.*

- *The charges-to-revenues ratio for RUs offering HS services is higher the shorter the travel time is. Exceptions to this tendency are Spain, where the value remains almost invariable for travel times up to 3 hours and only then increases, and Italy, where no tendency can be established.*

- *The consideration of investment costs by infrastructure charging systems results in lower margins over infrastructure charges for RUs offering HS services than for airways carriers. As a result of that (and as opposed to RUs offering conventional services on conventional railway lines), RUs offering HS services on HSL lose their advantage with regard to airways in terms of margins over infrastructure charges.*

- *The consideration of the railway's commercial speed by railway pricing systems negatively affects the competitiveness of HS railways compared to airways, since it implies lower margins over infrastructure charges for RUs than for airways carriers.*

With regard to the results of the quantification of the impacts on traffic volumes of a variation in the level of rail infrastructure charges, the following conclusions apply (given the assumptions made for the calculations):

- *A reduction of the current levels of charges to the level of marginal costs would result in very significant increases in traffic volumes (even if according to the assumption made, they are supposed to correspond to the minimum expected change): In the French case, where HS traffic is very intense at peak periods, the* *estimated yearly increases at the peak period resulting from a reduction of rail infrastructure charges to the level of the marginal cost of maintenance and renewals amount to 490.890 passengers for the Paris-Lyons link, and almost 690.800 passengers for the Paris-Lille link. In Spain, where HS traffic is considerably lower than in France, those yearly increases at the peak period would range from 150.000 to 265.000 passengers per year. The lower losses in the Italian network are mainly due to the fact that the peak period only lasts 3 hours, compared to the 5h30 and 5h for the French and the Spanish networks, respectively.*

- *It would seem that charging HSL only the marginal cost is not the optimal solution:*
  - *firstly, because the increases in forecasted traffic resulting from such a reduction (increases in traffic volumes up to 40% for the Paris-Lyons link) could result in insufficient infrastructure capacity and the ensuing raise in marginal congestion and scarcity costs that would result in the estimates of the marginal costs used for the calculations not being appropriate anymore.*
  - *secondly, one would be neglecting the high ability to pay that railway operators offering HS services on HSL seem to have and this would mean losing an important source of revenues meant for recovering part of the total infrastructure costs;*
  - *finally, one would as well be neglecting the opportunity cost of public funds, that is, the existence of budget constraints.*

- *If mark ups were fixed at the optimal level of charges calculated for the main national European HSL, traffic volumes would increase 20-30%, or even 60% in the Paris-Lyons link. Therefore, an important percentage of passengers seem to be deterred from using HS railways (at least at peak periods) as a result of the influence that the current levels of mark ups exert on ticket fares, which correspond to the final price to consumers (users).*

Concerning the results of the quantification of the impacts on mode split of a variation in the level of rail infrastructure charges, it can be concluded that:

- *The impact on mode split resulting from a reduction of infrastructure charges to the level of marginal cost of maintenance and renewals or to the optimal mark up seems to strongly depend on the initial commercial position of HS railways, this impact being higher in markets where railways position can be improved to a wide extent.*
  - *For initial market shares above 95%, changes in market share derived from*

a reduction on the level of rail infrastructure charges can be considered negligible, no matter what the level of the reduction in the rail infrastructure charges is. Indeed, reductions in the level of charges of more than 50% do not even change the mode split by 1 point.

- *For initial market shares comprised between 85% and 95% (and charges-to-revenues ratios ranging from 10% to 44%), the impact on mode split caused by a reduction of rail infrastructure charges reaches up to 5,5 points (assuming reductions of rail infrastructure charges of up to 100%, which allow reaching the marginal cost level).*
- *For initial market shares comprised between 50% and 85%, the impact on mode split strongly depends on the value of the charges-to-revenues ratio. For links with initial market shares of about 70% the maximal impact on mode split resulting from a reduction of rail infrastructure charges seems to be at around 17-19 points (assuming charges-to-revenues ratios lower than 40%).*

- ➢ *New HSL with initial market shares comprised between 50%-85% are the most penalised links by the setting of charges above marginal cost of maintenance and renewals and above the optimal level of mark up.*

Considering the previous conclusions, the answer to the main question raised in this PhD Thesis, “Which consequences do current levels of rail infrastructure charges implemented in the European framework have on the competitiveness of the high speed passenger services that run on the European railway network?”, can be answered as follows:

> *Current levels of rail infrastructure charges implemented in the European framework have a negative impact on the competitiveness of the high speed passenger services that run on the European railway network, particularly in the cases where the rail market share is currently low (below 80%-85%). These negative impacts correspond to reductions in potential traffic volumes of 20%-60% and to reductions in market share of up to 13 points for reductions of mark ups to the optimal level and for runs taking place in the morning peak.*

Governments have succeeded in implementing charging systems that allow recouping part of the high capital costs of high speed lines through charges, by considering the commercial position of high speed railways. However, the results obtained show that even in countries where there seems to be a clear market-based pricing (for instance, France), mark ups would have not been imposed after careful consideration of their consequences on the market position of railway undertakings in the market segment in question.

The first HSL built in Europe were characterised by optimal distances for HS runs and, therefore, high rail market shares with regard to airways. Contrary to those main links, the high speed links that should complement and allow the connectivity of the European HS network, do not follow the same patterns and have, consequently, lower rail market shares. Therefore, the optimal use of the future HS network, which is meant to promote sustainable development by allowing a modal shift from airways to railways, will require taking careful consideration of the level of mark ups above marginal cost applied to the infrastructure charges to be paid by trains running on the HS network.

This PhD Thesis exhorts those responsible for the determination of the level of mark ups above marginal costs to take into account that current charges are reducing the social benefits of the new lines by reducing traffic and leading to rail having a smaller market share when competing with air.

7.2. FURTHER RESEARCH

The results obtained in this PhD Thesis could be improved with further research in two main directions:

- The estimation of marginal costs of wear and tear
- The estimation of price elasticities of demand for links of the European high speed network

The issue of the estimation of the marginal cost of wear and tear is of great importance given the legislation framework defined by the European Commission. Since rail access charges should be based on the principles of short run marginal social cost, it is essential to have accurate estimations of the marginal costs incurred on the different types of infrastructures (conventional lines, upgraded lines, new high speed lines) by the different types of services (long distance services, high speed services, sub-urban services, freight services…). Currently, estimates for high speed and other intercity lines, for other passenger services and for freight are only available for the French railway network. Consequently, important contributions are still to be made in this field.

Regarding the issue of the estimation of price elasticities of demand for links of the European high speed network, very few estimates are available to date. However, as it has been seen, Ramsey-Boiteux pricing, consisting in pricing up more in those market segments which are least sensitive to price, is broadly applied in the countries with high speed lines charging mark ups to social marginal cost. Due to lack of data in this subject, in this PhD Thesis it has been assumed that the runs taking place on the high speed network can be considered to be part of a single market and, consequently, a single value of price elasticity of demand can be attributed to the whole network (the minimum value of price elasticity of demand available was used for the calculations of the impacts on traffic volumes and mode split resulting from a change in the level of rail infrastructure charges). Even if the assumptions made in this PhD Thesis when estimating the impacts on traffic volumes and mode split of a variation of charges give the minimal impacts to be expected, the conclusions of this PhD Thesis point to the fact that mark ups do not seem to have been imposed after careful consideration of their consequences for the market position of railway undertakings in the market segment in question. Not even in countries where there seems to be a clear market-based pricing. This could stem from a limited knowledge of the real price elasticity of demand of each high speed link. Therefore, further research in this field would be of great interest in order to improve the precision of the estimation of charges’ impacts on traffic volumes and mode split.

The author also envisages further research in the European international framework. To this date, infrastructure charges for international services are the result of adding the different charges established by the different national infrastructure managers. In order to promote international high speed services, it would be convenient to develop a pricing system for international high speed services. The results obtained in this PhD thesis concerning the quantification of the impacts that the implementation of mark ups above the optimal level have on traffic volumes and mode split, should pave the way towards the definition of appropriate and efficient mark ups above marginal cost.

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ANNEXES

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ANNEX A1

THE EUROPEAN HIGH SPEED NETWORK

A1.1. THE APPEARANCE OF HIGH SPEED RAILWAYS AND ITS CONTEXT

During the last decades, the need to travel has incremented in a very significant way as a direct consequence of the multiplication of economical exchanges and the evolution of our ways of life. As a result of this reality, the different means of transport have developed their infrastructure and their services in order to face this need to travel and to maintain or increment their market share.

The development of high performance road infrastructures and the use of the plane for medium and long distance routes, thanks to the introduction of jet planes, pushed railways in Europe into a declining situation in the late 1960s. As examples, we can remark the following realities:

- In France, the railway lost around 15 percentual points of market share between 1963 and 1967 in the Paris-Marseilles and Paris-Nice links (López-Pita, 1998), a loss that essentially benefited the plane, which won 11 of the 15 points mentioned above. Also, in the axis Paris-Southeast, and with a commercial speed of 128 km/h, the Paris-Lyons link lost a market share similar to the previous ones.

- In Spain, the number of travellers per kilometre came to a standstill at the beginning of 1965, remaining around 18.000 (data extracted from Casado Casado, 1993) and, while passenger transport by road went from 40% in the year 1950 to 80% in 1970, the railway experimented an opposite evolution, descending from 60% in 1950 to only 14% in 1970. In that period, the plane incremented its share, without surpassing, in any case, 6%-7%.

- In Italy, the situation was similar to the one of Spain. In only 5 years, from 1950 to 1955, road traffic in Italy went from a situation of equality with railways to a situation where road infrastructures nearly doubled their traffic compared to the railway (López-Pita, 1998). The evolution of modal distribution of medium and long distance travellers traffic during the 1955-1970 period remained negative for the Italian railway, which went from a market share of 38% to just 18%.

- In the seventies, the railway in Europe stood as the most affected transport mode against the advance of aviation and the private car, as a consequence of the extension of highways; indeed, the growth in modal distribution in the 1970-1980 period was of +2,0% for car transport, -1,9% for railways, -1,1% for bus transport, and +1,0 for aviation (Sánchez-Borràs, 2004).

Railway's regression was sharpened by the European Community poor intervention to solve the problem (from a railway point of view), as well as the bad economic situation that railways were suffering, although it is necessary to mention the actions of some organisations such as the UIC, whose concern about the future of the railway, in medium and long distance intercity links, led to the creation of the Commission "Recherche Prospective", with the goal of reflecting on the subject; as well as the appearance, in 1973, of the "European Outline Plan of Infrastructures", probably established on the basis of the discussions of the above mentioned Commission, which stated some of the more relevant aspects in order to achieve a significant railway role in medium and long distance travelling. Amongst those aspects, some stood out, such as the "desirable criterion" in terms of speed, which established that speed needs to be such that:

- "*the railway is able to offer a shorter travel time than the one the automobile needs, 2/3, if possible, of the time the road makes possible*".

- "*inside the 500 km distance zone (considering terrestrial distances), if it is possible, the duration of the railway trip be equal to the one offered by the plane, taking into account the time spent in city-airport transportation and back, and the waiting time that the aerial mode requires*".

In that period, commercial speed for roads was 90 km/h, therefore the first criterion translated into a desirable speed goal for railways of around 135 km/h, in the case of equal travelling distance, in a given route, for road and railways.

However, as **table A1.1** shows, these notable efforts, especially by some railway administrations such as the German, British and French ones, to improve the quality of their service, particularly in medium and long distance travellers' services (300 to 800 km), could not achieve the above mentioned "desirable criterion", with the exception of the United Kingdom and France. In the latter, the practical application of the results of studies elaborated by a "Multidisciplinary Group", created in 1967 with the goal of making experimentations towards the increment of the running speed, allowed for a major evolution in the maximum running speed in the French network during the 1970s, increasing from 10.000 km to 17.000 km the rail network adapted to maximum speeds of 150 km to 200 km/h in only six years (from 1970 to 1976).

TABLE A1.1 EVOLUTION OF THE MAXIMUM AUTHORISED AND COMMERCIAL SPEED (km/h)

Source: Author's elaboration, with data from Arduin (1991), La Vie du Rail, López-Pita (2006) and other sources

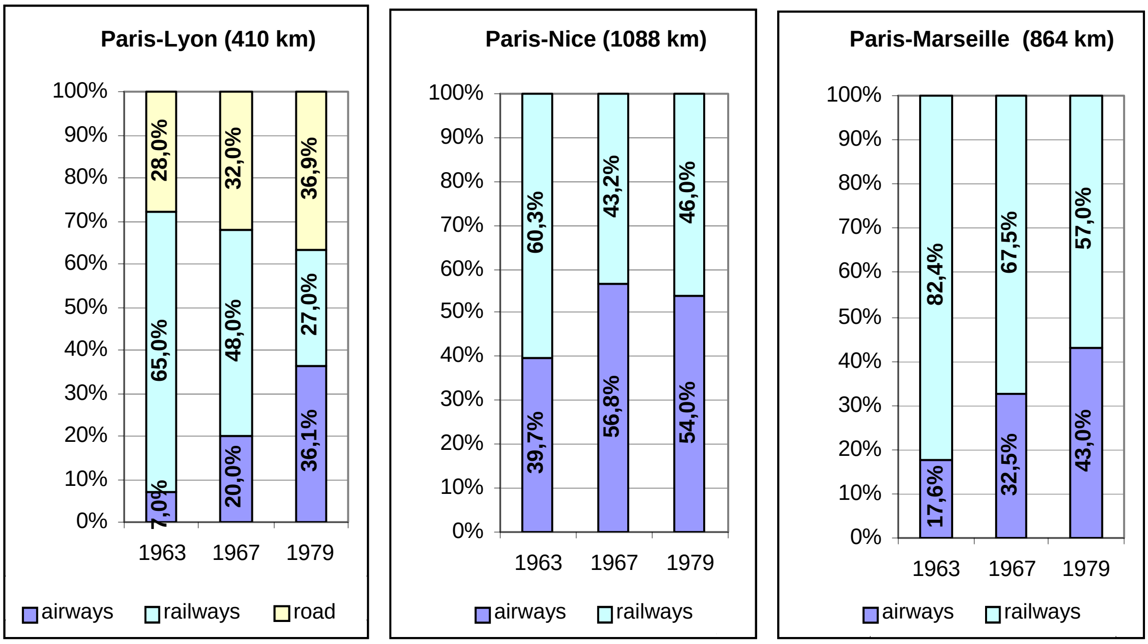
Year	France		Germany		Spain		Italy		UK		Sweden	
	Author.	Comm.	Author.	Comm.	Author.	Comm.	Author.	Comm.	Author.	Comm.	Author.	Comm.
1944	140											
1945											120	
1950		100										76
1957	150				120							
1960		128					150					
1965	160				140	96						
1967	200									120		
1970				110		95	180					
1972		145										
1973			200									
1975			200			98			200			
1976									200			
1979		152										
1980	260					102		120		140		114

Remarks:

- Author.: Maximal speed authorised
- Comm.: Maximal commercial speed

However, those increases on railway speed did not stop the tendency of loss of market share of the railway in France, already apparent in the 1960s, and that continued to occur in the 1970s especially in the links to the French southeast, (see **figure A1.1**), all of them surpassing the 400 km distance (Paris-Lyons: 410 km; Paris-Marseilles: 864 km; Paris-Nice: 1.088 km). Therefore, it can be concluded that the increase of speed, up to 140 km/h of commercial speed, with the resulting improvements in the French railway services, was not an effective measure for the railway to cover distances of more than 400 km. The development of an interior French network of faster and more reliable jet planes explains, to some extent, the significant transference of travellers from first class railway travellers to the plane.

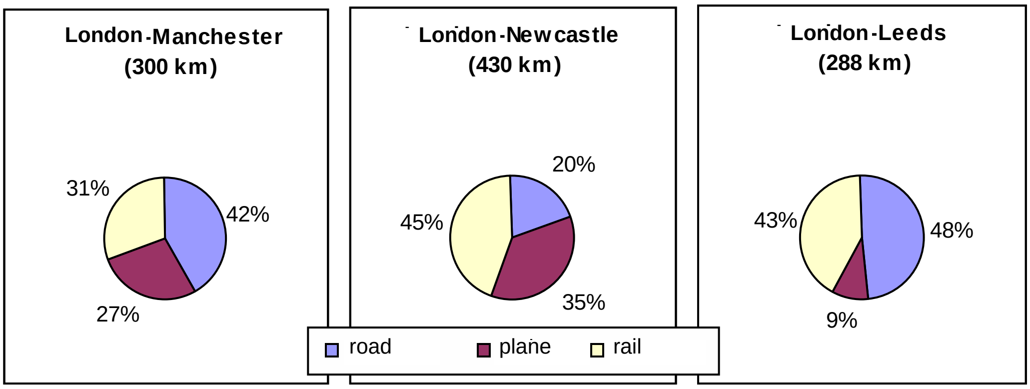
FIGURE A1.1 EVOLUTION OF THE MODE SPLIT IN SELECTED LINKS BETWEEN PARIS AND THE FRENCH SOUTHEAST
Source: Sánchez-Borràs (2004) with data from López-Pita (1998)



In the United Kingdom, the railway succeeded in achieving a significant market share in the late 1970s, for routes with a maximum distance of around 400 km (see **figure A1.2**). Nevertheless, in longer distances, the British railway was so helpless as the French in front of the plane's competition.

The helplessness of the railway in front of the plane's competition accounts for the impossibility of the railway of increasing its services at a speed level, for reasons of magnitude of the curve radius, as well as the development experimented by aviation and the improvement of the road network, which stopped the rail from achieving the above mentioned "desirable criterion". In fact, the maximum speeds achieved in the existing designs appoached the 200 km/h mark, and although these speeds were far higher than just a decade before, the development of aviation and the improvement of the road network resulted in the railway not being competitive against aviation and road transport in medium and long distance services (distances above 300 km), and this explains its continuous loss of market share in transport until 1980.

FIGURE A1.2 MODE SPLIT OF TRAVELLERS' TRAFFIC IN SOME ENGLISH ROUTES (1980)
Source: Sánchez-Borràs (2004) with data from different sources



Therefore, the necessity of building new railway infrastructures to increase its commercial speed and turn railways into a competitive mean of transport was clear. In this context, at the beginning of the 1980s, Europe began to think out the new role of the railway, and references to high speed started to appear.

A1.2. DEFINITION OF HIGH SPEED

It is difficult to find a uniform definition of the term "high speed". In fact, it seems that there is no single definition for such term, because the complex reality it covers allows for different interpretations, in case one wants to show its diversity or, on the contrary, to encompass its great diversity.

From the technical point of view, which reflects the above mentioned diversity, the border between conventional services and high speed ones is determined by a speed oscillating, generally, between 200 and 250 km/h. This border is marked by:

- the *geometry of the rail,* because of, among other factors, the limitation the existing cant imposes in terms of speed in the curves; and

- the *safety installations*: not modernised conventional designs are not enough to run at more than 200 km/h.

In some cases, additional differentiations are made, describing as "upgraded lines" ("lignes aménagées, in French") the services that run in the above mentioned speed range, and as "high speed or very high speed" ("grande ou très grande vitesse", in French) the ones that surpass 250 km/h or 300 km/h.

Although the technical definition of high speed stresses the speed achieved and the geometry of the rail, high speed is something more than the existence of a design with favourable geometrical features. According to the International Union of Railways (UIC, 2005), high speed can be defined as a new type of railway transportation, a system itself that encompasses at the same time:

- *New generations of high performance trains* (high speed trains *strictu sensu* and fast titling trains).

- The *infrastructures dedicated to high speeds* (300 km/h or more) or the *upgraded existing infrastructures* (for speeds of 200 km/h or even 220 km/h).

- *Highly sophisticated techniques for running and safety management*, for instance the ERTMS/ETCS[1] and GSM-R[2] interoperable systems.

- A great diversity of *new high quality services* (titling services, systems of information and reservation, restoration, on board and station services), adapted to customer's needs, which help to reinforce the competitiveness of the train.

According to López-Pita (2007), high speed can be considered as a system formed by different subsystems, the most important of which are:

- The *track*: high speed requires a track geometry with special features (curve radius, cant…).

- The *material*: the rolling stock for high speed runs has to allow for speeds higher than 200 km/h.

---

[1] ERTMS is the European Rail Traffic Management System, which results of the merging of two complex systems, the European Train Control System (ETCS) and the GSMR-R, railway derivation of the civil standard of telecommunications GSM. The ERTMS is one of the pillars on which the future European railway interoperability will stand. For more detailed information, see ERTMS (2007).

[2] GSM-R is a communication system adapted to the necessities of trains. For more detailed information, see Rubio (?).

- The *power collection*: the system of reception of power has to resist the trains high speed.

- The *safety installations*: high speed lines require specific safety installations in order to allow speeds above 200 km/h., at a running and brake level.

- The *commercial politics*: performances of high speed railways are different from the ones offered by conventional railway services. As a consequence of this, it is necessary to adapt the commercial politics to the profile of a customer attracted to high speed services.

On the other hand, the European Community prefers a definition that, contrary to the ones presented above, seeks to encompass the great diversity that encloses the term. In this sense, the concept of high speed railway is defined all over Europe in homogeneous and clear terms by the Directive on the Interoperability (EC, 1996), the Directive 96/0048/CE of July 23rd, 1996. According to this directive, lines have to fulfil the following requisites in order to be considered high speed (inside the Trans-European network):

- In terms of *infrastructure*, these are the lines considered to be high speed:

    - Lines specially built for high speed, equipped for speeds generally equal or above 250 km/h.
    - Lines specially upgraded for high speed, equipped for speeds around 200 km/h.
    - Lines specially upgraded for high speed, with a specific character because of topographic, relief or urban difficulties, the speed of which will have to be adjusted case by case.

- In terms of *rolling stock*, high speed trains of an advanced technology have to be conceived to guarantee secure and brakeless runs:

    - A minimum speed of 250 km/h on the lines specially built for high speed, allowing, in appropriate circumstances, to achieve speeds over 300 km/h.
    - A speed of around 200 km/h on the specially upgraded existing lines.
    - The maximum speed possible on other lines.

- In terms of *operation system*, high speed services must have an excellent compatibility between the features of infrastructure and rolling stock.

A1.3. BRIEF HISTORICAL RECORD OF THE EUROPEAN HIGH SPEED RAIL NETWORK

In 1967, Louis Armand, SNCF's[3]general director, declared that "the future of passenger transportation by railway cannot be conceived without the development of high speeds". To develop them, he provided two options:

- *To modernise* the existing lines, in order to surpass a certain level of speed, of around 160 km/h; or

- *To build new lines*, as the Japanese had done with the Tōkaidō.

After exhausting the possibilities to develop sufficient speeds to confront the competition of the plane for distances above 300 km, through the modernisation of existing or conventional lines (as remarked on the previous section), SNCF decided to develop the second line of action.

This second line was concreted in a feasibility study of new high performance infrastructures in the Paris-Lyons, Paris-North and Paris-East corridors, which led to the approval, in 1974, of the project for the Paris-Lyons corridor by the French Board of Ministers, the subsequent opening of the Southern section of the line (Saint Florentin-Sathonay) in 1981, and of the remaining of the line, two years after. The new infrastructure allowed to reduce travel time between Paris and Lyons from three hours and fifty minutes to just two hours, thanks to the geometrical features of the track, which allowed top speeds of 270 km/h.

The technical, commercial and economical success of this new Paris-Lyons line showed the potential of high speed railways facing the growing demand of transport, and it led, as we will now see, to the development of a high speed rail network within a European scope.

A1.3.1. Development of the proposal for a high performance European network

The idea of developing a proposal for a European high speed rail network emerged on May 17th, 1985, during a meeting between a group formed by the 10 railway companies of the European Community and Mr. Signorile, Italian Minister of Transportation, who was then president of the board of transport ministers in the Community.

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[3] SNCF, Societé Nationale des Chemins de Fer Français (National Society of French Railways).

This idea took shape when the general directors of the networks assigned the binomial DB/SNCF, (Mr. Heinisich and Mr. Walrave, by then representatives of the German and French railways, respectively), to develop this proposal.

The market share of the railway in European international traffic, which had been shrinking for the previous ten years, justified the need to proceed with this action.

In addition, the process of liberalisation that would accompany the railway (see annex A2), anticipated an increase in competition from the other means of transport, in particular from the aerial ones.

The idea of building a European high speed network progressed ahead: the European Commission presented its will to develop a high speed European network (final report COM/86/341, June 30th, 1986) and the European Parliament adopted, on September 16th, 1986, a resolution in the same direction.

In the socio-economical context of the European high speed network, the main issues (around which the network would have to be articulated) were (CENIT, 2004):

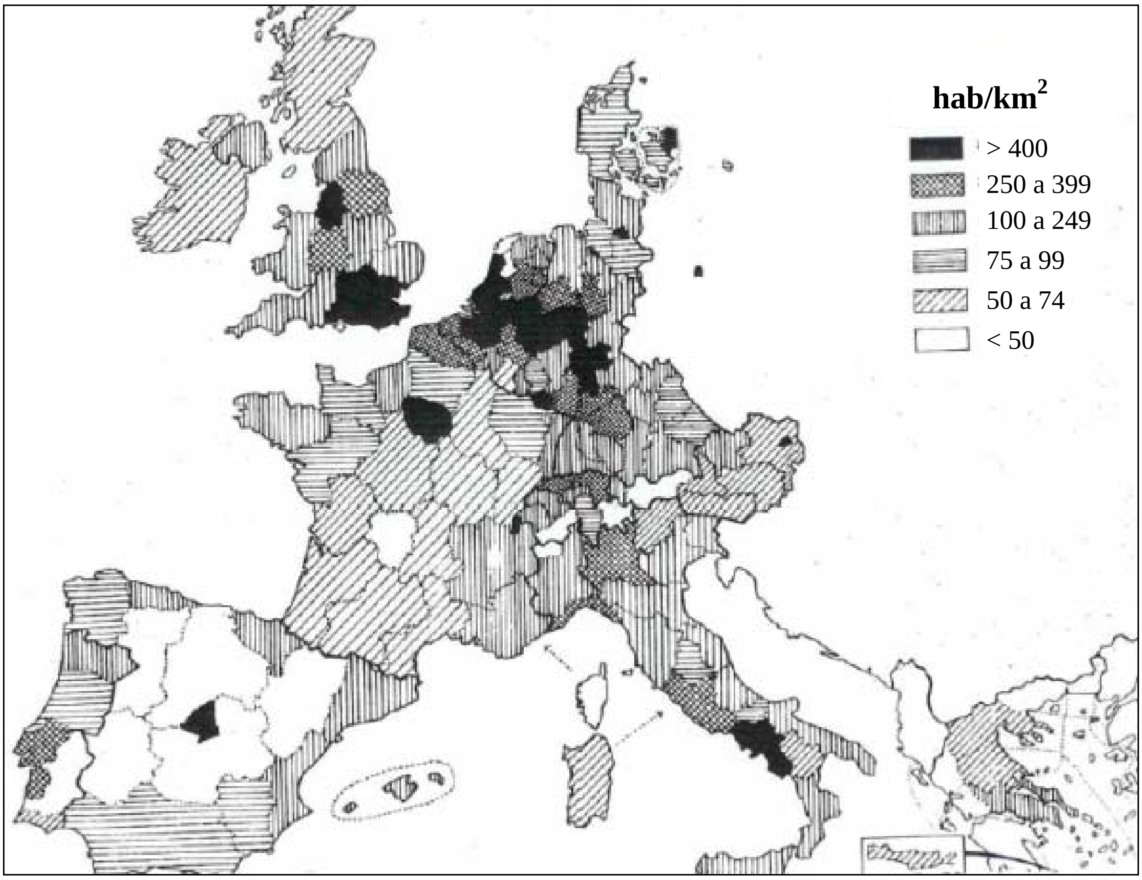
- The localisation and situation of human and economic potential
- The obstacles that could hinder their communications

Regarding the obstacles, Western Europe presents the particularity of being split in two by the Alps. This geographic obstacle hinders, therefore, easy and fast relationships between two subgroups:

- A first subgroup, in the North, inscribed in a quadrilateral encompassing London-Hamburg-Munich-Zurich-Geneva-Lyons-Paris, characterised by the importance of its population (more than 140 millions), its huge demographic densities and the size of the agglomerations (see **figure A1.3**).

- A second subgroup, in the South, inscribed in a triangle encompassing Turin-Milan-Venice-Naples-Rome-Genoa, which groups more than 40 million of inhabitants, but is located (with the exception of the plain of the Po and the axis Milan-Bologna) in an area of relatively rugged terrain, due to the presence of the Apennine dorsal all along the Italian peninsula.

FIGURE A1.3 DENSITY OF POPULATION IN EUROPE IN 1984
Source: CENIT (2004), extracted from Eurostat (1984)



These observations marked the issues around which a modern network of transportation in Western Europe had to be articulated, and which can be summarised in four points:

- A Glasgow-Marseilles corridor.

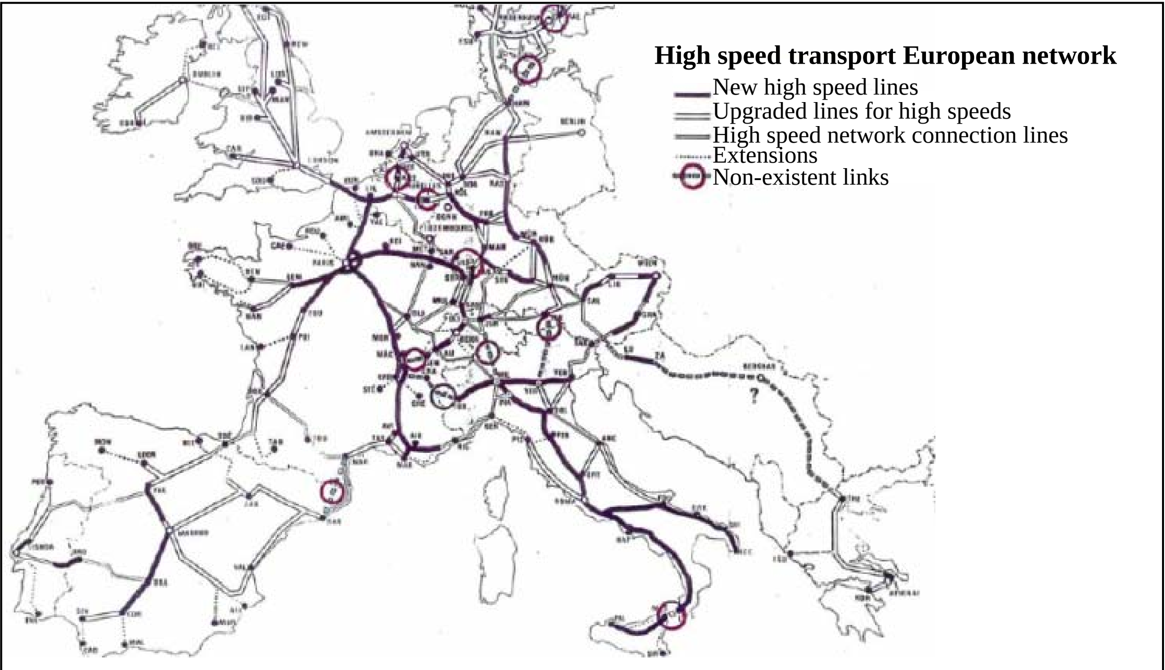
- An X-shaped double corridor, beginning in Amsterdam and Hamburg, with a converging point in the Frankfurt/Stuttgart region, and continuing, on one direction, towards Zurich, Milan and Naples, and on the other, towards Munich, Salzburg and Vienna.

- A transversal corridor, joining the previous two, from London to Hamburg, passing through Lille, Brussels, Cologne, Hanover and Bremen.

- Four demographic East-West axis:
  - Paris-Frankfurt-Munich
  - Lyons-Zurich-Munich

- Lyon-Venice
- Barcelona-Marseilles-Nice-Milan

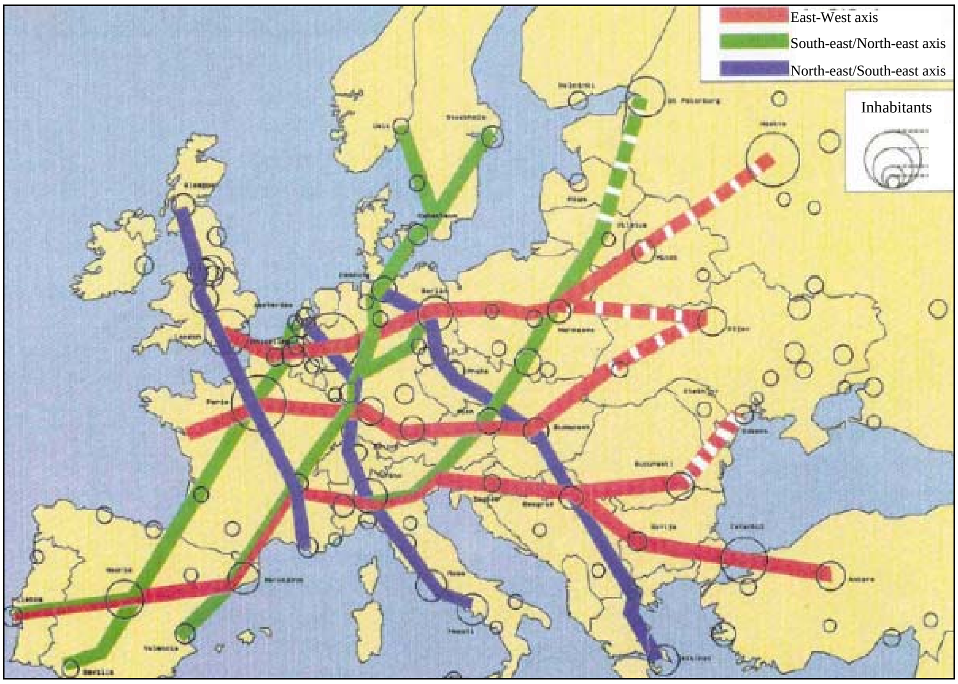
FIGURE A1.4 EUROPEAN NETWORK OF HIGH SPEED TRANSPORTATION (1988 PROPOSAL)
Source: CENIT (2004), extracted from the European Community of Railways (1988).



This is how the proposal emerged for a European high speed rail network, presented by the European Community of Railways (see **figure A1.4**). This proposal included the construction, until the year 2015, of 8.000 km of new lines and the modernisation of 11.000 km, with the goal of achieving speeds between 160 and 200 km/h. However, this network cannot be considered complete without adding the use of existing lines, be it for connecting high speed lines between them, or extending them towards the periphery to allow for the eccentric regions to have access to high speed.

Subsequently, the changes that took place in Central and Eastern Europe in the 1990s generated a strong increase of mobility needs. This fact favoured that the "European Outline Plan of high speed links" was completely revised to take into account the profound political evolution of the European continent, which required the development of an East-West axis, with the goal of developing a Pan-European network (**figure A1.5**).

FIGURE A1.5 MAIN EAST-WEST AXIS
Source: CENIT (2004), extracted from UIC (1984).

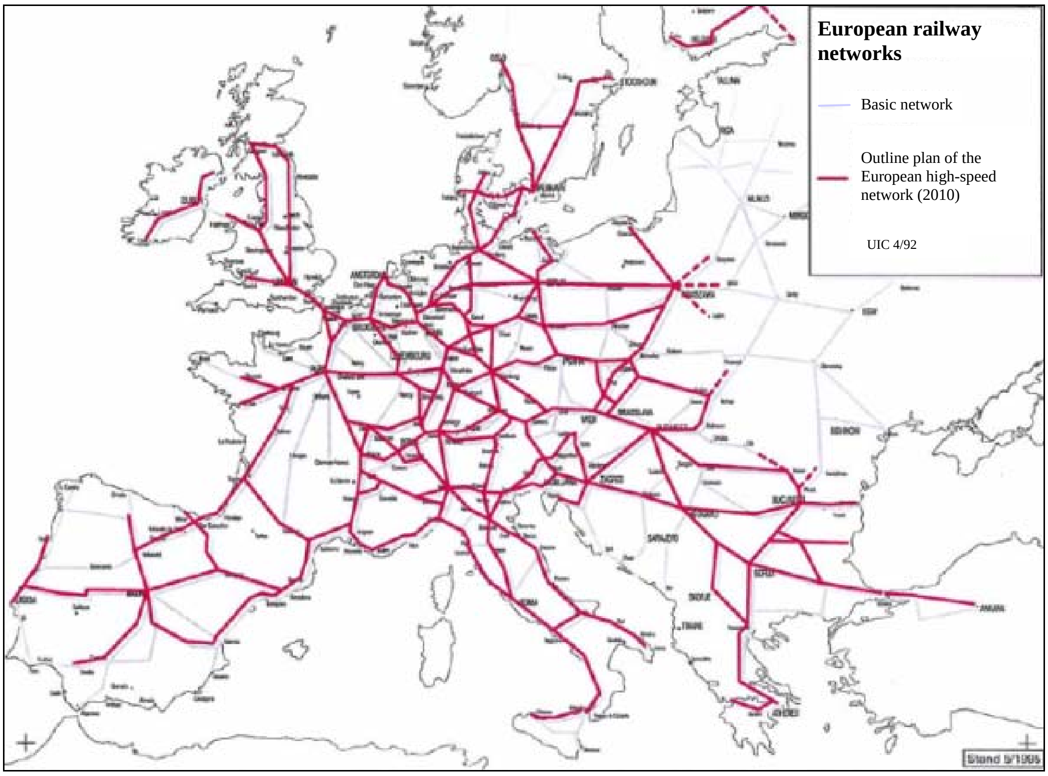


The new network that was proposed was composed by a central part corresponding to the more populated area, and it allowed to link, not only the main agglomerations in the area, but also eight regions located on the periphery through access gates:

- Link between the British Isles and France through London
- Link between Germany and Scandinavia through Hamburg
- Link, through Warsaw, between Western Europe and the Baltic countries, Belarus, Russia and Northern Ukraine
- Link between Western and Eastern Europe through Budapest, Southern Ukraine, Moldova and Russia
- Link between Western Europe and Belgrade through the Balkans
- Link between Central Europe and Southern Italy through Bologna
- Link between Spain and France through two accesses: one through Catalonia (Barcelona-Portbou) and one through the Basque Country (Irun)

This new proposal presented a highly meshed network which allows for a communication service in the whole of the European continent (**figure A1.6**). This network combines three types of lines:

FIGURE A1.6 RESULTING NETWORK FROM THE OUTLINE PLAN OF INFRASTRUCTURE
Source: CENIT (2004), extracted from UIC (1994).



- Completely new high speed lines
- Lines upgraded to increase the speed up to 200-225 km/h
- Existing lines that play a linking and dissemination role

For the whole of Europe (not counting the ex Soviet Union), the considered network consists of 35.000 km, of which 20.000 km correspond to new lines.

The implementation of the European network should allow achieving especially efficient railway running times between the main European cities, while reducing the duration of the journey an average of 50%, in a fairly homogenous way, for all European regions.

A1.3.2. The European high speed network: evolution and sate of the art

The **figure A1.7** presents in a summarised way the evolution of the history of new constructed high speed lines in Europe up to December 2008.

FIGURE A1.7 NEW HIGH SPEED LINES IN EUROPE IN THE YEAR 2008
Source: Author's elaboration with data from UIC (2002 y 2006) and other sources

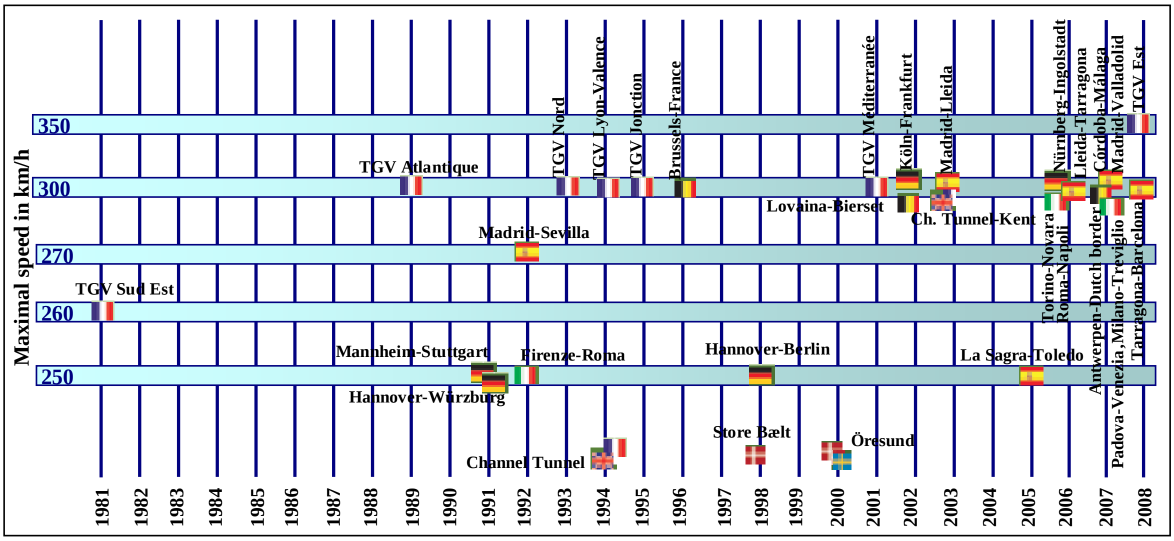
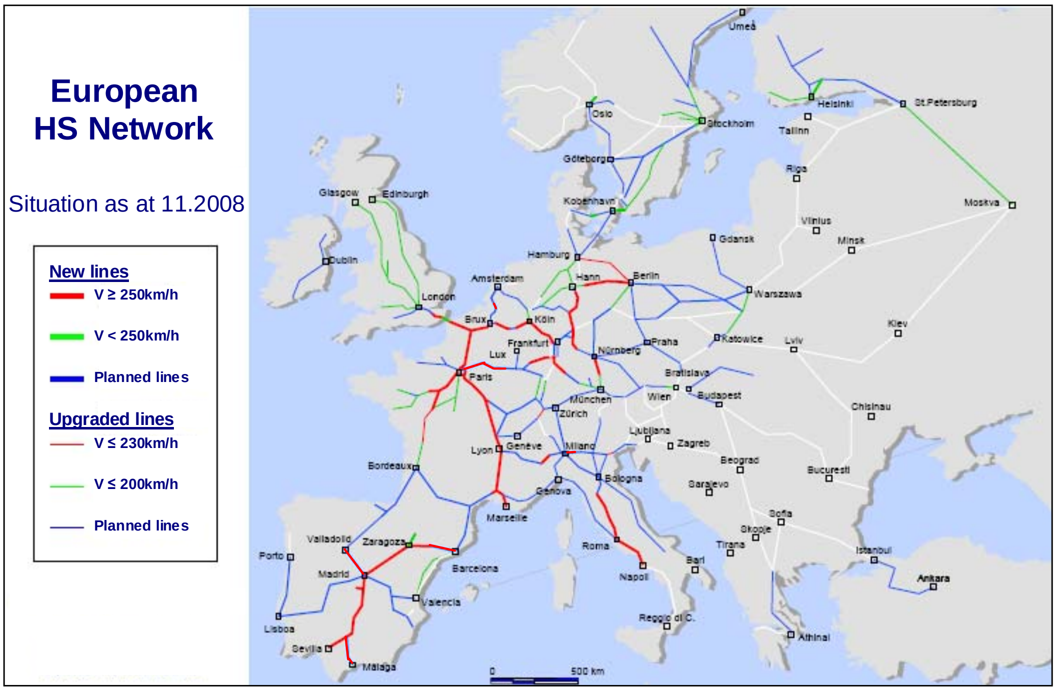


FIGURE A1.8 EUROPEAN HIGH SPEED RAIL NETWORK. STATE IN NOVEMBER 2008
Source: Adapted from UIC (2006).



At the end of 2008, the European network of new (purpose-built) high speed lines was constituted by 5.244 km, around 2.000 km more than in 2002, when the network consisted of 3.260 km according to data provided by the International Union of Railways (UIC, 2002), and around 800 km less than the kilometres foreseen by the UIC (2005) for 2010.

TABLE A1.2 GEOGRAPHIC DISTRIBUTION OF NEW RAILWAY LINES IN EUROPE (STATE IN DECEMBER 2008)

Source: Author's elaboration with data from Sánchez-Borràs (2004), CENIT (2005), Barrón (2006), UIC (2006), Revue Générale des Chemins de fer (2006), Ministerio de Fomento (2007), Groupe SCNB (2007) and other sources.

Country	Line	Extension (km)		%
		Parcial	Total	
France	TGV Sud Est (Paris-Lyon) TGV Atlantique (Paris-Le Mans) TGV Atlantique (Courtalain-Tours) TGV Rhône Alpes (Contournement de Lyon) TGV Rhône Alpes (Satolas-Valence) TGV Nord – Europe TGV Nord (Lille-Belgian border) TGV Jonction (interconnection) TGV Jonction Atlantique TGV Mediterrannée TGV Est (Paris-Baudrecourt)	417 176 106 38 83 330 26 70 32 295 300	1.873	35,7
Spain	Madrid-Sevilla Madrid-Lleida La Sagra-Toledo Lleida-Tarragona Córdoba-Málaga Madrid-Valladolid Tarragona-Barcelona	471 470 22 83 155 180 68	1.449	27,6
Germany	Mannheim-Stuttgart Hannover-Würzburg Hannover-Berlin Köln-Rhein/Main (Frankfurt) Nürnberg-Ingolstadt	99 327 264 215 89	994	19,0
Italy	Roma-Firenze Roma-Napoli Torino-Novara Padova-Venezia Milano-Treviglio	246 220 84 23 23	596	11,4
Belgium	French border-Tubize Lovaina-Liège Amberes-Dutch border	71 62 40	173	3,3
United Kingdom	Channel Tunnel-Fawkham Junction	74	74	1,4
France/UK	Channel Tunnel	52	52	1,0
Denmark/Sweden	Öresund	18	18	0,3
Denmark	Store Bælt	15	15	0,3
TOTAL		5.244		100

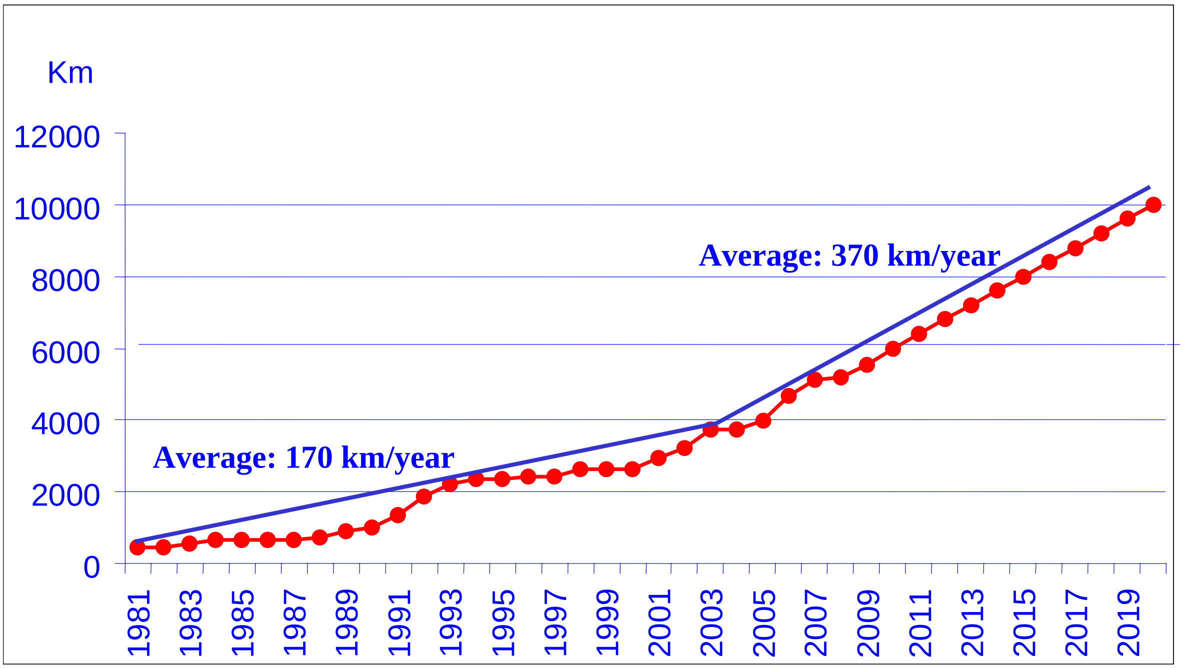
The above mentioned 5.244 km of new high speed lines are roughly distributed as follows: 36% in France, 28% in Spain, 19% in Germany, 11% in Italy, and the remaining 6% in Belgium, the United Kingdom, Denmark and Sweden (see **table A1.2**).

As it can be seen in the **figures A1.7** and **A1.8**, the European dimension was achieved with the partial service implementation of the PBCAL network (Paris-Brussels-Cologne-Amsterdam-London) in 1994, and subsequently with the opening in 2000 of the Öresund, which connects Denmark to Sweden.

A1.3.3. The future design of the European high speed network

The International Union of Railways, UIC, foresees that the European high speed network will evolve in the next years at a pace of 370 km of new lines per year (see **figure A1.9**), until forming in 2020 the high speed network presented in the **figure A1.10**.

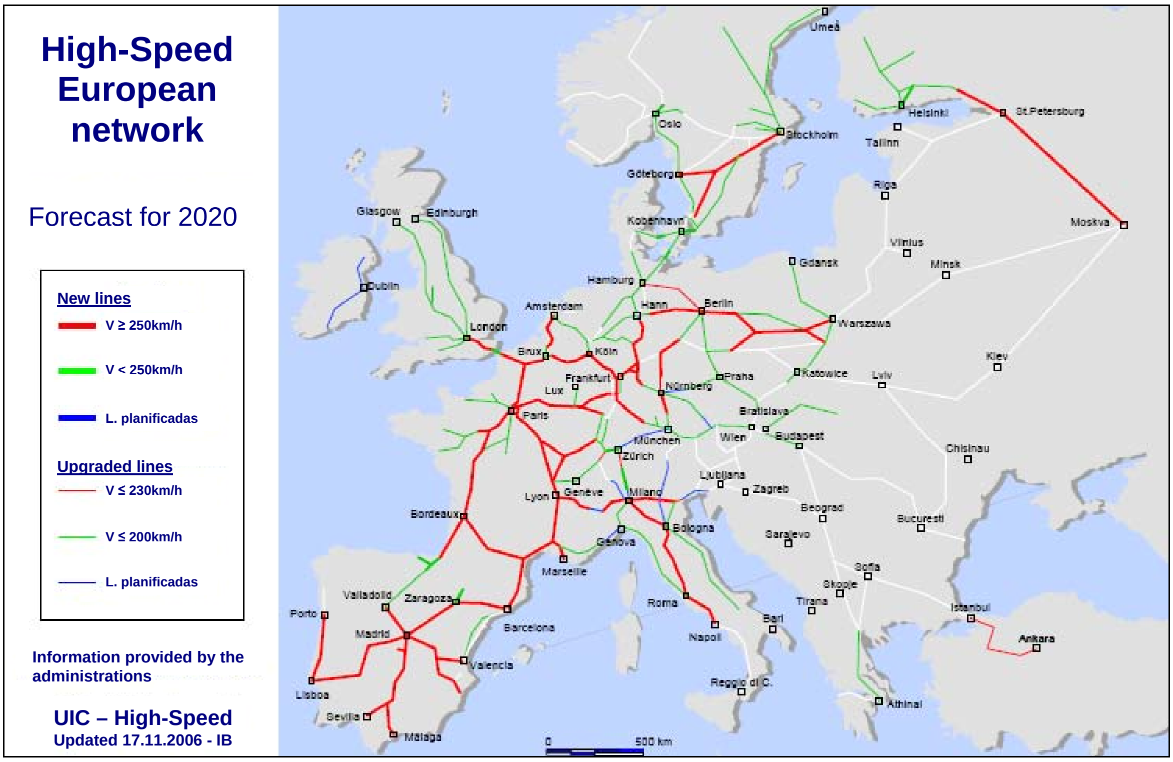
FIGURE A1.9 PREVISION OF THE EVOLUTION OF NEW HIGH SPEED LINES IN EUROPE
Source: Barrón (2005).



According to UIC (2005) previsions, in the 2020 horizon there will be around 6.000 km of new high speed lines through which new international services will run, among them Eurostar, Thalys and ICE on the PBCAL network, and Rhealys (the grouping of French, Luxembourgian, German and Swiss railways) on the TGV East European line.

Furthermore, other high speed services will be implemented from Barcelona (or Madrid) to France (Toulouse, Marseilles, Lyons, Paris) and Switzerland (Geneva).

FIGURE A1.10 EUROPEAN HIGH SPEED NETWORK FORECAST FOR 2020
Source: Adapted from UIC (2006).



An extension of the high speed network in Central and Eastern Europe, as well as the surmounting of the Alpine dorsal towards Italy, is forecast for the period comprised between 2010 and 2020.

In the 2020 horizon, the more populated Swedish cities (Stockholm, Gothenburg and Malmö) and the two most populated Portuguese cities (Lisbon and Porto) will be linked by high speed lines. In Central and Eastern Europe, the development of high speed will be done essentially on upgraded lines.

A1.4. PROFITABILITY AND FINANCING OF THE EUROPEAN RAILWAY NETWORK

As we have seen in the previous section, nowadays the development of the high speed network in Europe is important, especially in Spain, France, Italy, Belgium, the

Netherlands, Germany and the United Kingdom. Nevertheless, not all the high speed projects, concluded, in construction or in a very advanced state of planning, are economically attractive (see **table A1.3** as an example), because they present low IRR[4] values (less than 5%). Their implementation is nevertheless justified by the fact that the strictly financial profitability is not the only one to be considered.

TABLE A1.3 PROFITABILITY OF THE FRENCH HIGH SPEED LINES INCLUDED ON THE OUTLINE PLAN OF HIGH SPEED LINES IN FRANCE, APPROVED BY THE GOVERNMENT IN 1991
Source: López-Pita (1998) with data from SNCF.

Project	IRR profitability (%)	
	Financial	Socio-economical
Aquitaine	7,5	10
Auvergne	3,1	6,7
Bretagne	7,4	13,6
Côte d'Azur	8,4	11
Est	4,3	8,8
Grand Sud	5	12
Interconnexion Sud	8,2	9,6
Lyon-Torino	6	10
Limousin	2,4	4,4
Languedoc-Roussillon	6,1	9
Midi-Pyrenées	5,5	6,5
Normandie	0,1	3,0
Provence	9,8	13
Pays de la Loire	5,4	7,7
Picardie	4,8	5
Rhin-Rhône	5,9	10,7

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[4] The IRR (Internal Rate of Return) is the rate which makes the present net value equal to zero. Algebraically, PNV = 0 = $\Sigma_{i=i\ldots n}$ NB_i / $(1+IRR)^i$, where PNV is the present net value, NB_i is the net benefit of the year i, and IRR is the internal rate of return. The rule to make or not an investment using the IRR is this: when the IRR is higher than the interest rate, the performance that the investor would obtain making the investment is higher than the one he would obtain in the best alternative investment, so the investment is convenient. If the IRR is lower than the interest rate, the investor is not inclined to make the investment.

Indeed, from a socio-economical point of view, be it at a national or European level, the implementation of a project can gain a great interest. Hence the importance of quantifying the socio-economical advantages of these new infrastructures.

The consideration of socio-economical profitability in the evaluation of the convenience or inconvenience of constructing a new high speed line forces to resort to public financing (European Union, State, local administrations, public organisations, etc).

From the above paragraphs it can be deduced that the profitability of high speed lines is very variable. Depending on it, high speed railway projects can be classified as (Arduin et al., 2002):

- High speed railway projects with a **positive and high global financial profitability**

- High speed railway projects with a **low global financial profitability**

The features of both theoretical cases are specified in **table A1.4**.

The low economical profitability of some of the high speed lines has led, in spite of their social profitability, to a delicate economical situation for the railway.

With the goal of revitalising the railways of the European Union, and reorganising their economical situation, the European Commission has adopted several measures, which are included in annex A2.

TABLE A1.4 THEORETICAL CASES OF PROFITABILITY OF HIGH SPEED RAILWAY PROJECTS

Source: Author's elaboration with data from Arduin et al. (2002).

Global economical profitability of high speed railway projects	
Positive and high	**Low**
- The revenues produced by the project in the future allow the investments, the operation and the maintenance of the infrastructure managers and the railway undertakings to be globally profitable.	- The revenues produced by the project in the future do not allow the investments, operation and maintenance of the infrastructure managers and the railway companies to be globally profitable.
- No subsidies from the State nor the local government is required.	- There are two variants:
- A pure and simple financing of the project by loan from the capital markets is enough to approve the project within the limits of industrial and commercial risks.	- Variant 1: The railway operation is enough to pay the investments, operation and maintenance of railway undertakings. In this case, a certain subsidy from the State and the local governments for the infrastructure investment is necessary to finish the project. It corresponds to the case of high speed lines projects with a medium volume of traffic and a high investment.
- It corresponds to the case of high speed lines projects with a very high volume of traffic.	- Variant 2: The railway operation is not enough to cover the investments, operation and maintenance of railway companies. It corresponds to the case of the projects of special high speed lines aiming to the European territory planning with a relatively high investment.

ANNEX A2

THE RESTRUCTURING OF RAILWAYS IN EUROPE

A2.1. THE TRADITIONAL ORGANISATION OF RAILWAYS IN EUROPE (1940s-1990s PERIOD)

The traditional organisation of most railways all around the world in the post-war period (1940s), until the 1990s, corresponds to an integrated public monopoly, which manages railway transportation at a national level. In that period, the traditional railway companies were auto-regulated companies, that is, they worked as operators, national regulators and inspectorates, all at the same time. In fact, until the past decade, every European state organised and produced their own railway transport, without worrying about what the neighbouring states did.

As a justification of why these services were offered through monopolies protected by their own states, Sala (2000) cites the following reasons:

- *High investment demands*: Railway companies were considered until very recently natural monopolies, in that those companies have very high fixed costs that can only be recouped through a provision by a system of economies of scale, that is, with big companies that can end up having reduced marginal costs.

- *Market failures as the top economical justification for direct intervention of the State*: It was argued that, without State intervention, services could not be provided because of the so-called “market failures”[5]. It was thought that no private entrepreneur would find incentives to invest in those sectors and to offer the products or services.

- *Justification of a political nature concerning people’s rights*: It was considered that private organisations could hardly provide and guarantee people’s rights (which have to be provided in a universal manner and with no hint of economical

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[5] A market failure, in economy, is a situation where markets do not efficiently organise the production or the allocation of goods and services to the consumers. For economists, the term applies when inefficiency is particularly dramatic, or when it is suggested that an institution outside the market (as the government, a public institution or a collective of associated people) could be more efficient and produce better results than private market initiatives.

discrimination in its allocation), because the final goal of such organisations is to obtain profits.

Furthermore, the monopolistic position of the traditional railway companies of the EU was favoured by the existence of significant technical and legal obstacles to enter the market. Among them, Pietroantonio et al. (2004) cite the following barriers:

- *Fragmented licence scheme*: Until the implementation of the First Railway Package (see the following section for more information on this subject), only already established national operators owned a licence to provide trans-European services.

- *Lack of interoperability*[6]: Differences in the conception of the different national railway networks hindering the provision of uninterrupted services existed in the European Union until recently and, in some cases, remain existent. Among these differences there is the rail gauge, different electric voltages, signalling systems, the dimension of platforms, load parameters, operation norms and the professional certification.

- *The licences for driving staff of locomotives and trains*: Until the last decade of the XXth century, licenses for driving staff of locomotives and trains were not recognised between European countries.

- *Locomotives and leasing*: The high price of new locomotives and their lack of technical interoperability reduced the possibility of creating a new railway company.

The traditional organisation of railways in Europe presented a series of inefficiencies, typical of the monopolist phenomenon. They can be summarised as follows (Petitbó, 1997 and Sala, 2000):

- The prices set by monopolist companies are higher than the prices the companies set in absolutely competitive markets.

- The production of goods and services in monopolised markets is lower than the production in competitive markets.

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[6] Pietrantonio et al. (2004) define interoperability as “the ability of any railway company to run their stock in any part of the European railway network without interruption”.

- In monopolist markets there is a net loss of welfare for the whole of the society, because the producer's surplus is positive (it reflects a rent transfer from consumers to companies).

- Lack of innovation, technological as well as organisational.

According to Obermauer (2001), those inefficiencies led to several economical problems:

- Low productivity and low efficiency (the internal inefficiency translates into a slow reaction in front of the changes in consumers' demands and preferences.
- High wages costs.
- Low market share, both in the passenger transport and freight transport markets.
- Significant debts on the long run.

Therefore, this structure was characterised by the low quality of the service provided and the mounting deficit that reached unsustainable levels. The report presented by the Commission to the Council about the application of a Community normative on railways at the end of the 1970s defined the situation of railway companies as economically and financially alarming, which forced railway administrations to increasingly depend on State subsidies.

Calthrop (2005) gives two reasons to explain the low quality of service provided by big monopolistic companies in railway transport. Both refer to political implication:

- On the one hand, the *railways were* traditionally *managed as a part of a government's ministry, with low incentives* for infrastructure managers to adapt to market requirements. In addition, in some cases railway management had to face conflicting incentives coming from several branches of government. Indeed, the ministers of transport, economy, industry, regional development, etc, had all different interests in the railway sector. Local politicians were added to this picture, focused on promoting local interests above national ones.

- On the other hand, *in many cases politicians have tried to expand railway services without wanting to pay for them*. The lack of funds resulted in the accumulation of debts by the railways.

All these economical problems, derived from the bad functioning of the traditional organisation structure of the European railway and combined with technological arguments that have questioned the traditional geographical borders of these services, triggered the organisational change that the European Union decided to make, through the implementation of a railway legislation at a European level, which nowadays defines a significant part of the juridical framework of railway activities in the European Union.

As a result of this, the rules of the game have substantially changed, and in most European countries, railway markets have been opened to competition.

In the following section we will present the restructuring, on a legislative level, that the railways in Europe have undergone in the past few years.

A2.2. RAILWAY POLICY OF THE EUROPEAN UNION

A2.2.1. Railway policy of the European Union within the context of European Transport Policy

The juridical framework of railway activities is presently defined in great part by the European legislation. This legislation is the result of the European Union railway policy, framed within the European Transport Policy, one of the axis of the present European policies, because of its economical and social significance.

We can distinguish five stages in the Common Transport Policy (Calvo Soria, 2006):

The *first stage*, which comprises the period between 1958 and 1972, begins after the approval of the constitutive Treaty establishing the European Economic Community, in 1957, and marks the beginning of the Common Transport Policy. During this period a memorandum was published on Common Transport Policy, as well as an Action programme. For the first time, both documents considered the direct liberalisation of transport, as a tool to achieve the goals of the Treaty.[7] The more significant achievements of the first stage are the limitation of State intervention in some fields, as well as the approval of a series of regulations that affected the different areas of the Transport Policy.

The *second stage* of the common transport policy, that goes from 1973 to 1981, is characterised by the following goals: to achieve the free running of transport services, the harmonisation of the competition conditions and the creation of a Common Market of Transport based on a non-intervention functioning. During that period a series of political initiatives were raised towards that goal, pushing liberalising measures in road transport, a harmonisation of norms regulating the relationship between railways, railway

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[7] Among the objectives of the treaty in the transport field there is the free circulation of goods.

undertakings and States, some improvements in air transport and an improvement on infrastructure coordinating the different national plans while considering a transport network on a European level.

The *third stage*, encompassing the period 1983-1992, marked the true impulse for the common transport policy, coupled with the great transformation of the European Community, which was born with the White Paper on Internal Market execution[8], which formulates recommendations destined to guarantee the free provision of services. The Maastricht Treaty of 1992[9] and the approval of the White Paper[10] on the "future development of the common transport policy" marked the essential impulse for the construction of transport policy. While the first one articulated the figure of trans-European networks for the transport, telecommunications and energy sectors, the second stated the transition from a sectorial structure of the different modes of transport to an integrated conception based on sustainable mobility, and engaged, in particular, to promote the trans-European transport networks, through the improvement of the connections between Member States and the interoperability between networks, while respecting the limitations derived from environmental protection.

The *fourth stage*, beginning in 1993 and ending in 2000, started with the liberalisation of road freight transport in January 1993. It was followed by the liberalisation of regular passengers transport services in 1999. Also, an action programme was approved that contemplated three significant actions: in the first place, the improvement of the quality in order to create integrated transport systems with advanced technologies, taking also into account environmental protection and safety; on the other hand, the improvement of the single market functioning with the aim of fostering efficient and easy-to-use services; and finally, the development of the external dimension, improving the quality of transport connections between the European Union and bordering countries. Also significant was the appearance of the White Paper of 1996[11], where the revitalisation of the Community railway transport was established as a precise strategy.

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[8] Internal Market White Paper, point 137 (memorandum from the Commission to Parliament, the Council and the Two Sides of Industry). COM (88) 320, June 1988.

[9] The Maastricht Treaty corresponds to the Treaty of the European Union (TEU), which constitutes a stepping stone in the European integration process, surpassing for the first time the initial economical goal of the Community (to build a common market) and providing a vocation of political unity to it. The Maastricht Treaty officially establishes the name "European Union", which from 1992 substituted the name European Community.

[10] A Commission White Paper is a document containing proposals for Community action in a specific area and usually follows an extensive consultation process at European level. When a White Paper has been favourably received by the Council, it can become the action programme for the Union in the area concerned (CER, 2004).

[11] Commission White Paper, 30 July 1996, "A strategy for revitalising the Community's railways" [COM (96) 421 final – not published in the Official Journal].

Finally, the publication of the White Paper of 2001[12] marks the beginning of the *fifth stage*, marked by the configuration of the present and future programme of transport policy. In this period, the transport policy of the Commission is articulated around the necessity of modifying the equilibrium between transport modes, with the aim of achieving a sustainable development. In this sense, one of its objectives is revitalising railway transport as a strategic sector.

Regarding railway transport policy, the five stages mentioned above can be grouped in three periods:

- A first stage that goes from 1958 to 1980.
- A second stage that encompasses the period 1980-1990.
- A third stage, from 1990 to the present.

In the following sections each one of them is characterised.

A2.2.2. First stage of the EU railway policy: 1958-1980

The first stage of the EU railway policy is characterised by the situation presented in annex A1 and the introduction to annex A2. That is, on one hand, the small relevance of transport policy measures developed at a European level, and on the other, the delicate situation of railway companies, derived from the inefficiency of their monopolistic organisation.

It is important to remark that this stage begins with the approval of the Treaty on European Community in 1957, which marks the beginning of a common transport policy, and saw a first impulse in The Hague Summit of 1969, which enabled to activate the coming into force of a common commercial policy.

A2.2.3. Second stage of the EU railway policy: 1980-1990

The second stage of EU railway policy encompasses the 1980s and is characterised by the definition of common transport policies, and in particular of the railway mode.

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[12] Commission White Paper, “European transport policy for 2010: time to decide” [COM (2001) 370 final].

In this stage, the new role of railways is raised, with the appearance of references to high speed, combined transport and infrastructure, the latter having been forgotten in the previous period.

High speed railways, introduced in Europe in 1981 with the inauguration of the first high speed line, TGV Southeast, in France, gave a new direction to railways, which saw in this new technology, successful in the technical, commercial and economical fields, a way to face the growing transport demand.

The considerable reduction of journey times that the high speed allowed in medium and long distance links helped the evolution of European passenger railway traffic between 1980 and 1990, and led to the idea, at a Community level, of elaborating a proposal for a European high speed network in 1985, as seen on annex A1.

A2.2.4. Third stage of the EU railway policy or the stage of Community legislation: 1990 to nowadays

The third stage of the EU railway policy could be christened as the stage of Community legislation, due to the significant number of directives that have appeared since the beginning of the 1990s.

This stage has given rise to a very important railway reform at a European level, with the goal of “improving the efficacy, the quality and the economic efficiency of railway services and stimulating the growth of railway markets, guaranteeing a high level of performance in security terms” (CEMT, 2002).

This reform also stresses the improvement of the quality of European railway services in favour of the competition game, as well as the framework of alliances, with the goal of substituting national borders with a commercial logic, creating railway markets at a continental level.

The railway reform performed by the EU since the 1990s can be divided into four phases of regulation and liberalisation:

- A first phase of reforms, starting with the approval of Directive 91/440/EEC on the separation of accounts between infrastructure management and transport operations, complemented with two other directives (Directive 95/18/EC and Directive 95/19/EC), on the licensing of railway undertakings and on the allocation of railway infrastructure capacity and the charging of infrastructure fees.

- A second phase, known as First Railway Package, with the improvement of competition, the creation of more and better international railway freight services and the improvement of the efficient use of infrastructure capacity as main objectives.

- A third phase, marked by the implementation of the Second Railway Package in 2004, which aims at opening all the European railway network to domestic and international freight traffic, and to reinforce the safety and facilitate interoperability as well.

- A fourth phase, including future reforms, among them the Third Railway Package, with the intention of advancing in the process of configuration of the integrated European railway space, and starting the liberalisation process in passenger transport, in the whole of the Community context.

In the following sections the main characteristics of each one of the regulation and liberalisation phases that constitute the reform process are summarised.

A2.2.4.1. First phase of EU reforms: Directives 91/440/EC, 95/18/EC and 95/19/EC

The first phase of the European Union reforms started with the approval of Directive 91/440/EC[13] on the separation of accounts between infrastructure management and transport operations.

This Directive was the first step towards the liberalisation of the railway sector, and consisted in giving a certain autonomy or independence to the railway companies, which in the member States were under public ownership, and beginning to develop competition in the field of international connections in railway freight transport (Trans-European networks).

This Directive forced the introduction of a separation of accounts between infrastructure management and transport operations (see section A2.4.2.2 for more details), both activities in a monopoly regime. In addition, it settled the basis for the access of other operators to the railway networks, and recommended giving solutions to the debt problem of the railway sector, as well as the introduction of autonomy in the management of railway companies in front of their governments.

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[13] Council Directive 91/440/EEC of 29 July 1991 on the development of the Community’s railways, nº L 237, of 24 August 1991, by which access right to railway infrastructure is granted in any place of the Union.

Four years later, in 1995, this directive was revised and complemented by two other directives, namely, Directive 95/18/EC[14] on the licensing of railway undertakings and Directive 95/19/EC[15] on the allocation of railway infrastructure capacity and the charging of infrastructure fees. With the revisions mentioned above, the European Union took the first steps to introduce free access in its limited expression of international access through "international groupings" of railway companies, especially the ones already established.

These directives showed that, even if the proposed opening was limited, its organisation was not easy; indeed, Directives 95/18/EC and 95/19/EC showed that the opening of the market implied dealing with numerous problems (Bergougnoux, 2000), from the definition and procurement of licences, to the allocation of railway capacities, and the definition of charging principles for the use of infrastructure (see chapter 1 for more information on charging principles).

The Community railway action programme can thus be summarised in this first phase as articulated around three main principles:

- Independence at legal level
- Freedom of management
- Financial reorganisation

CICCP (2006) summarises the final goal of the reform process launched in this stage as "being able to achieve real separation and not only the separation of accounts between infrastructure management and transport operations, so that public or private railway undertakings can manage transport operations with commercial criteria, paying in turn a charge to the infrastructure manager for the use of infrastructure".

This model of reform represented, in a certain way, the transposition on a European scale of the Swedish logic, the main orientations of which were (Crozet, 2004a):

- Separation, at least on the accounting level, between infrastructure management and railway operation.

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[14] Council Directive 95/18/EC of 19 June 1995 on the licensing of railway undertakings (Official Journal of the European Union, nº L 143, 19 June 1995, pp. 70-74).

[15] Council Directive 95/19/EC on the allocation of railway infrastructure capacity and the charging of infrastructure fees (Official Journal of the European Union, nº L 143, 27 June 1995, pp. 75-78).

- Clarification of access conditions of third parties to the network, both in the technical field (train-path allocation, candidate certification…) and in the economic one (public rates for infrastructure charges).

- Support to accept competition between several railway undertakings.

Even though in this first phase of reforms of the European Union the step towards the revitalisation of railways was important, because they meant a boost for the liberalisation and the introduction of competition in the railway field, the changes derived from the implementation of directives 91/440, 95/18 and 95/19 had a rather “marginal impact” (Bergougnoux, 2000).

This fact led the Council to establish new strategies to accelerate the railways restructuring and revitalisation process. With this goal, the Commission presented three proposals of directives in 1998, which “should guarantee a higher transparency in charging and infrastructure allocation to railway undertakings” (Calvo Soria, 2006). The Commission clarified these proposals with the adoption of a White Paper on the charging of transport infrastructures[16].

The materialisation of these proposals led to the so-called “First Railway Package”, the implementation of which represents the start of the second stage of EU reforms in the railway sector.

A2.2.4.2. Second phase of EU reforms: First Railway Package

The First Railway Package represents an important attempt to reform the railway sector, although it only refers to railway freight transport.

Its main objectives are:

- To improve the competition
- To create more and better international railway freight services
- To improve the efficient use of the infrastructure capacity

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[16] Commission White Paper of 22 July 1998: Fair payment for infrastructure used – a phased approach to a common transport infrastructure charging framework in the EU (COM (98) 466).

All these goals have to be achieved with the liberalisation of the sector through the introduction of free access and forms of direct competition, at least in the TERFN[17] in a first stage.

This first package includes three directives:

- Directive 2001/12/EC on the development of the Community’s railways (amending Council Directive 91/440/EEC), the objective of which consists in reinforcing the management autonomy of the infrastructure managers in front of the historic operators and establishing the figure of the railway regulator.

- Directive 2001/13/EC on the licensing of railway undertakings (amending Council Directive 95/18/EC), which seeks to enable the opening of the market, allowing the concession of licences to all the railway operators established in the European Union.

- Directive 2001/14/EC on the allocation of railway infrastructure capacity and the levying of charges for the use of railway infrastructure and safety certification.

Section A2.4.2.1 studies with more detail the contents of Directive 2001/14/EC.

A2.2.4.3. Third phase of EU reforms: Second Railway Package

The third phase of European Union reforms started in April 2004 with the Second Railway Package. Its implementation aimed at promoting the application of the First Railway Package and filling the existing gaps, in order to reinforce railway safety and interoperability, as well as to accelerate the opening of the railway freight transport market.

The Second Railway Package, with the title of “Towards an integrated European railway area” (COM (2002) 18), was approved by the European Union in January 2002, but it was not until March 2004 that the Parliament and the European Council reached an agreement, captured in the Official Journal L164 of 30 April 2004.

This second railway package has the objective of opening all the European railway network to domestic and international freight traffic. Among other significant proposals, the following actions, necessary to establish a regulating framework to revitalise railways, stand out (EIM, 2002):

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[17] TERFN corresponds to the initials of the Trans-European Rail Freight Network, which accounts for 50% of the total railway network of the EU and carries 80% of the traffic (according to data from Pietrantonio et al., 2004).

- A common approach to railways safety.

- Updating of the directives on interoperability of the rail systems.

- Creation of the European Railway Agency, as an efficient tool of the Community to unite and support the processes of safety and interoperability.

- Adherence of the Community to the Intergovernmental Organisation for International Rail Transport (OTIF).

In particular, the Second Railway Package translates into:

- *A Regulation by which a European Railway Agency is created*: Regulation (EC) No 881/2004 of the European Parliament and of the Council of 29 April 2004, establishing a European Railway Agency (Agency Regulation). The goal of this regulation consists in finding common solutions of safety and interoperability;

- *A Directive by which the Directive 91/440/EC is amended*: Directive 2004/51/EC of the European Parliament and of the Council of 29 April 2004 amending Council Directive 91/440/EEC on the development of the Community's railways. With this amendment of Directive 91/440/EEC, already amended in the Directive 2001/12/EC of the First Railway Package, Directive 2001/51/EC expands the access rights to the infrastructure;

- *A Directive by which the Directives 96/48/EC and 2001/16/EC are amended*: Directive 2004/50/EC of the European Parliament and of the Council of 29 April 2004 amending Council Directive 96/48/EC on the interoperability of the trans-European high speed rail system and Directive 2001/16/EC of the European Parliament and of the Council on the interoperability of the trans-European conventional rail system;

- *A Railway Safety Directive*: Directive 2004/49/EC of the European Parliament and of the Council of 29 April 2004 on safety on the Community's railways and amending Council Directive 95/18/EC on the licencing of railway undertakings and Directive 2001/14/EC on the allocation of railway infrastructure capacity and the levying of charges for the use of railway infrastructure and safety certification.

The European Railway Agency, with head office in Valenciennes-Lille, elaborates common safety goals, standardised methods that allow achieving these goals, and common safety indicators that allow measuring them in a harmonised way on a European level. Therefore, it establishes common criteria to evaluate the demand of safety certificates from the European railway undertakings and to avoid the risks of competition distortion between States.

The Directive 2004/51/EC expands the opening of the network to the railway undertakings that provide international freight services (1 January 2006). It also stipulates that the railway undertakings will have access rights to the railway network to operate all kinds of freight services, be it national or international (1 January 2007).

On the other hand, Directive 2004/50/EC has the goal of advancing more rapidly in the way of interoperability, between the networks constituting the conventional network, and ensuring that the geography of the interoperability coincides with the one of the opening of the network (Calvo Soria, 2006).

Finally, Directive 2004/49/EC seeks to guarantee railway safety through public and understandable norms. Standing out among these, there is the establishment of a clear procedure for the concession, contents and validity of the safety certificates that all railway companies must have in order to use the European network, as well as the creation of an authority responsible for safety.

A2.2.4.4. Fourth phase of EU reforms: Third Railway Package

The Third Railway Package can be considered to be the beginning of the fourth phase of railway reforms of the European Union, because it is expected to complete the liberalisation and regulation in the EU framework.

The Third Railway Package was presented by the European Commission in March 2004. It includes a communication, two proposals of Directive and another two of Regulation, specifically:

- Communication from the Commission to the Council: Continue the integration of the European railway system (COM(2004) 141 final). This communication contains new proposals of action with the goal of continuing the railways reform and completing the normative framework.

- A proposal for a Council Directive on the opening of the market to international passenger services before January 1, 2010[18]. This proposal of liberalisation of the passenger services complies with the intention of opening international passenger services to competition, as stated in the White Paper "European transport policy for 2010: time to decide'" (EIM, 2005). The general principle of this Directive is the opening to competition on the basis of free access to the networks and service provision, allowing Member states to limit that access if there is a public contract for a specific service, the economic equilibrium of which can be threatened (CICCP, 2006).

- A proposal for a Council Directive on the certification of train crews[19], that will entail the authorisation for the whole of the European Community network (general regulations) and specific certificates for the rolling stock, lines and Regulations that directly affect the operators.

- A proposal for a Regulation on the rights of international passengers[20] to reinforce railways' appeal.

- A proposal for a Regulation on the quality of freight transport services[21].

This third package also foresees the liberalisation of freight transport, both in the international as well as in the national contexts (from 1 January 2006).

The liberalisation of passenger traffic, proposed in this Third Package, was not a priority of the First Package for reasons (according to Pietroantonio et al., 2004) of a purely political nature (because the passenger services come close to highly sensitive national areas such as the justification of general interest services and security worries) and for several economic reasons.

A2.3. FIRST ATTEMPTS TO REORGANISE RAILWAYS IN EUROPE

In many cases, given the inefficiencies of the traditional organisation of railways in Europe, some railway companies took a first step towards reorganisation, before the

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[18] COM (2004) 139. Proposal for a Council Directive amending Directive 91/440/EEC on the development of the Community's railways.

[19] COM(2004) 142 Proposal for a Directive of the European Parliament and of the Council on the certification of train crews operating locomotives and trains on the Community's rail network.

[20] COM(2004) 143 Proposal for a Regulation of the European Parliament and of the Council on international rail passengers' rights and obligations.

[21] COM(2004) 144 Proposal for a Regulation of the European Parliament and of the Council on compensation in cases of non-compliance with contractual quality requirements for rail freight services.

Directive 91/440/EC of 29 July 1991 on the development of the Community's railways was implemented, expressing for the first time the will of the European Commission to restructure railways in Europe.

The countries that decided to make a first attempt at reorganising railways essentially wished to achieve improved efficiency, a financial reconstruction, the reinforcement of competitiveness and a reduction of both obligations and long-term debts.

The first attempts at railway reorganisation tried to reorganise the company into "business units". This reorganisation consisted in going from a unitary and integrated organisation of all the activities to a functional arrangement and a system of territorial division of the service operation, with a decentralisation of the management and, therefore, of the accounting processes.

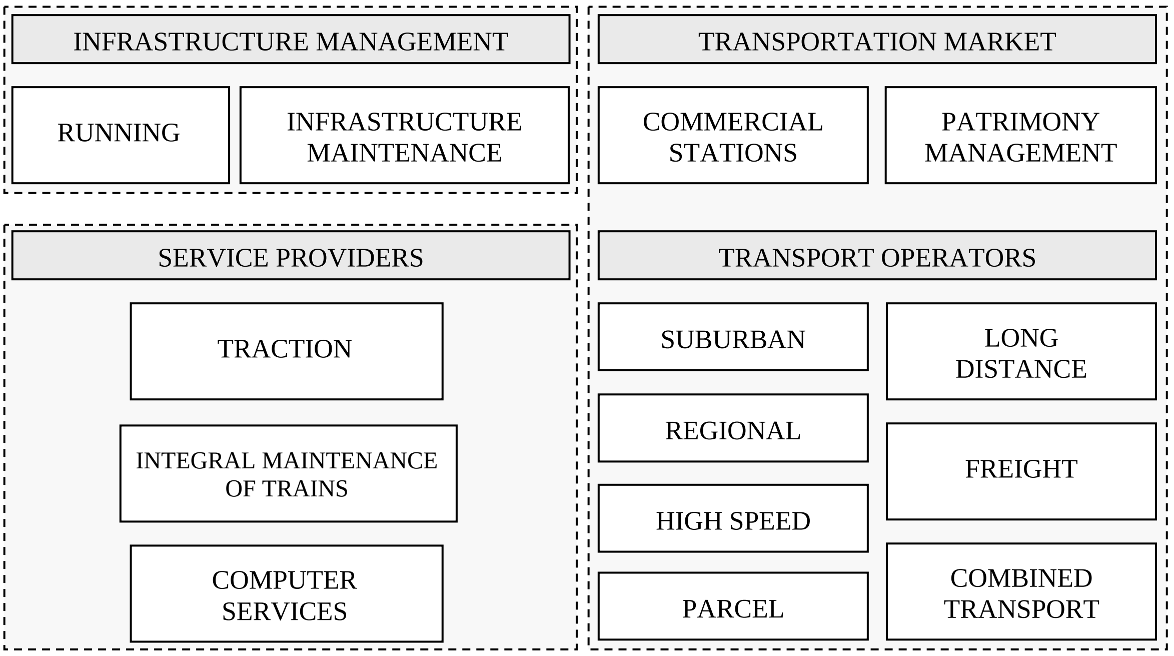
More specifically, a business unit is defined as "an organisation unit that does all the basic business activities, such as supply, production and sales, regarding a product or a range of products that satisfy a certain market profile or a defined geographical area. The criteria to form business units can be: to group the similar products together in ranges or families, to group the markets together according to the customers needs, or finally, to create business units from a combination of the other two, that is, to group together the products that satisfy similar needs" (Sala, 2000).

Some cases, such as the reform process of the railway system in the United Kingdom, went further, and a corporatisation of the company was applied. The corporatisation consisted in the creation of segments of integrated public services into business units, aiming explicitly at the business; these aims materialised into independent financial goals and specific organisational structures. That is, in corporatised state companies, the company operates under commercial law, where the State operates merely as a shareholder. In some cases, as in the United Kingdom, there was a clear break: the separate components of the old state-owned company were privatised, and even in some cases it was all privatised at once (Calthrop, 2005).

In the Spanish case, that is in the case of Renfe, at the beginning of the 1990s management was decentralised through the creation of service units that would elaborate their own balance sheet and would have a specific balance. In this way, a greater flexibility and response capacity were obtained.

The creation of business units took into account the recommendations of the European Union, and, for that reason, the service activities were split from the ones concerning the infrastructure, and on the other hand, the different markets where the transport activity was concentrated were delimited. As a result, Renfe’s new internal structure came to be the one represented in **figure A2.1.**

FIGURE A2.1 RENFE’S ORGANISATION ARQUITECTURE
Source: Adapted from Sala (2000)



Remarks:
- The Parcel business unit disappeared in 1996 as an activity and as a business
- The Long Distance business unit changed its name to Great Lines (*Grandes Líneas*) at the end of the 1990s

As can be deduced from the previous figure, the new organisation was structured in three fundamental pillars:

- *Infrastructure management*: including the business units of Running, basically dedicated to the regulation and train-path allocation, and Infrastructure Maintenance, in charge of the track and catenary conservation, as well as the systems of safety signalling and train control.

- *Transportation market*: the business units belonging to this group are in charge of selling the services. For that reason, they generate direct revenues from the clients. Until 1996, the business units were grouped in two general divisions: Integrated Systems (made up of Suburban –Cercanías–, Regional –Regionales–, High speed –

Alta Velocidad– and Parcel –Paquetería–) and Logistic Services (constituted by Long Distance –Largo Recorrido–, Freight –Mercancías–, and Combined Transport –Transporte Combinado–). Two other business units of the transportation market complete this group: Commercial Stations and Patrimony Management.

- *Units providing internal services*: The Traction (constituted by the locomotives and some engine drivers), Integral Maintenance of Trains (a unit responsible for the maintenance of locomotives, cars, wagons and auto-propelled trains) and Computer Services business units belong to this group.

A2.4. REORGANISATION OF THE RAILWAY IN EUROPE

A2.4.1. The reference of other "public utilities"

Public utilities are services that can be defined as those activities that depend on a network of fixed infrastructures (tracks, cables, pipes, etc.) that enable the connections and transport systems of the service (Sala, 2000). They are also known as network industries, because they offer products and services to the consumers through a "network infrastructure".

This type of industries is mainly characterised by (EC, 2006):

- Very high fixed costs to develop their infrastructures.
- Decreasing average costs as production increases.
- The existence of advantages derived from the joint production of different goods within a company.
- Producing essential services and having certain non economical obligations imposed by the governments, due to the great importance of ensuring the continuity of the supply of services.

As happens in other economical sectors, *public utilities* do not encompass a single and homogenous economic activity, but they involve a group of activities or "components", many of which produce goods or services for its use in other activities. An example of components of the railway sector could be the infrastructure and the running of trains.

Until a few years ago, the organisation of *public utilities* (railways, postal services, telecommunications, electricity, natural gas, among many other regulated industries) was the result of a vertical integration[22] of a non-competitive component of the industry and a competitive one. **Table A2.1** shows a summary of these components for several industries or sectors.

TABLE A2.1 INDUSTRIES WITH COMPONENTS SUBJECT TO BEING PROVIDED ON A COMPETITIVE REGIME AND WITH NON-COMPETITIVE COMPONENTS
Source: Sala (2000) and OECD (2001b).

Sector	Infrastructure (Non-competitive)	Services (Competitive)
Oil	Transportation networks	Extraction, refinery, distribution, service stations
Air services	Airports Traffic control centres	Passenger and freight transport and complementary services
Maritime transport	Port facilities	Pilot services, harbour services
Electricity	High-voltage networks	Generation, local distribution, capillary network
Telecommunications	Long distance wiring Satellites	Sound and image transmitters
Gas	High-pressure transmission of gas	Production and storage
Railways	Railway network	Passenger and freight transport

In this context, a basic problem appeared: the owner of the non-competitive component could have the incentive and at the same time the ability to restrict the competition in the non-competitive component, controlling the terms and conditions with which the rival companies of the competitive component had access to the non-competitive component.

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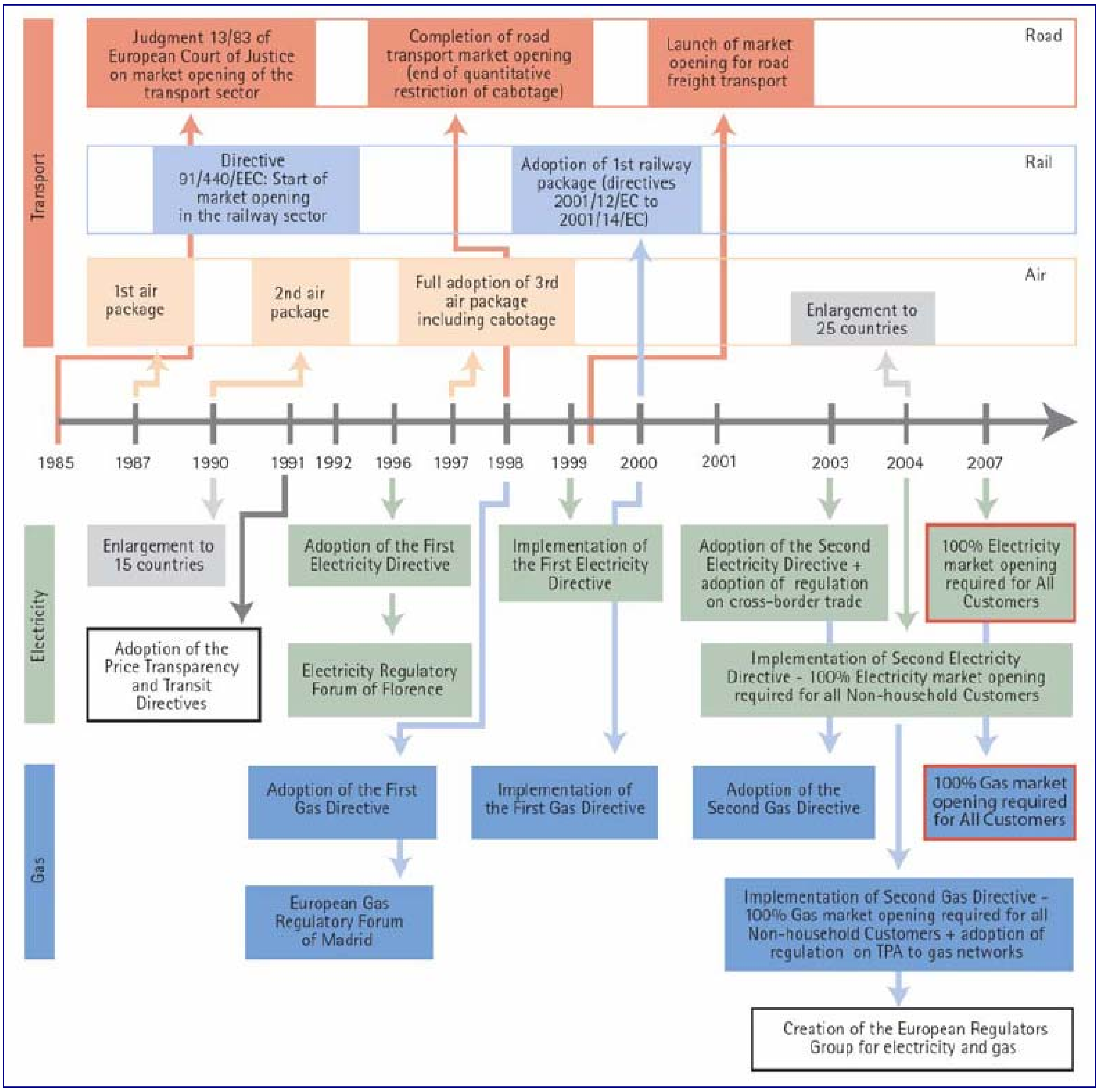
[22] We talk about a vertical relationship when two goods or services are complementary in the production of the final good or service (OECD, 2001a). In the case of the railway market, the train services and the track are complementary in the delivering of railway transport services, therefore they are in a vertical relationship.

This was against the laws of free competition that should rule, according to the sentence enacted by the European Court of Justice in 1985, in all markets, including the transportation market too.

The search of a solution to this problem has led to reorganise the structure of many *public utilities* in recent decades, liberalising and in some cases privatising the market, with the goal of allowing competition in the competitive components of the industries.

FIGURE A2.2 CHRONOLOGY OF THE RESTRUCTURING OF SEVERAL NETWORK INDUSTRIES IN THE EUROPEAN NETWORK
Source: Taken from CENIT et al (2007b)



Nowadays the restructuring of railways in Europe is still on its way. It combines liberalisation with market integration, and it follows similar lines to the ones adopted for the markets of other network industries, where the restructuring started several years ago (see **figure A2.2**).

Given the possible similarities between railway liberalisation and those carried out by other industries, being familiar with the reform experienced in other *public utilities* is of interest. Therefore, the following sections explain the reasons of this restructuring of the *public utilities* and the tools used in different markets in order to carry it out.

A2.4.1.1. Reasons for the reorganisation of the *public utilities*

As advanced in the previous section, the *public utilities* were constituted until recently by a non-competitive component of the industry and by a competitive component. The main reason was the presence of traditional economies of scale that led to a natural monopoly. That is, it was considered that a single company could adjust to the demand in a more efficient manner than any combination of two or more companies.

However, the introduction of competition in the competitive components of an industry may offer significant benefits, such as (OECD, 2001a; Sala 2000):

- Stimulating innovation, efficiency and efficacy in the competition activities.
- Ability to offer a wider range of alternatives to the consumer, increase the product differentiation and achieve a higher customer demand satisfaction.
- Limitation of the regulation scope, allowing for more efficient and specific regulations.
- Overcoming national markets borders and expanding the markets, adapting to the optimum dimension of the sector[23].

The tools that allow introducing and developing competition in the competitive components of a *public utility* are presented in the following section.

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[23] In this sense, the technological advances experienced in recent years have questioned the traditional geographical borders of certain network industries. For instance, the introduction of cellular technology marked the disappearance of the borders imposed by state companies based on fixed facilities. In the energy sector, new generation systems have appeared that are no longer strictly linked to the territory. On the other hand, relatively new telematic networks such as the Internet set off from an essentially international and global principle.

A2.4.1.2. Tools to protect and to promote competition in the competitive component of an industry with competitive and non-competitive complementary segments

The promotion of competition in the competitive component of an industry with competitive and non-competitive complementary segments can be done, on a political level, through several tools:

- *The regulation of access to the non-competitive component of an integrated incumbent firm*: this tool consists in regulating the terms and conditions of access of rival companies in the non-competitive services, through the participation of a regulator (see **figure A2.3**).

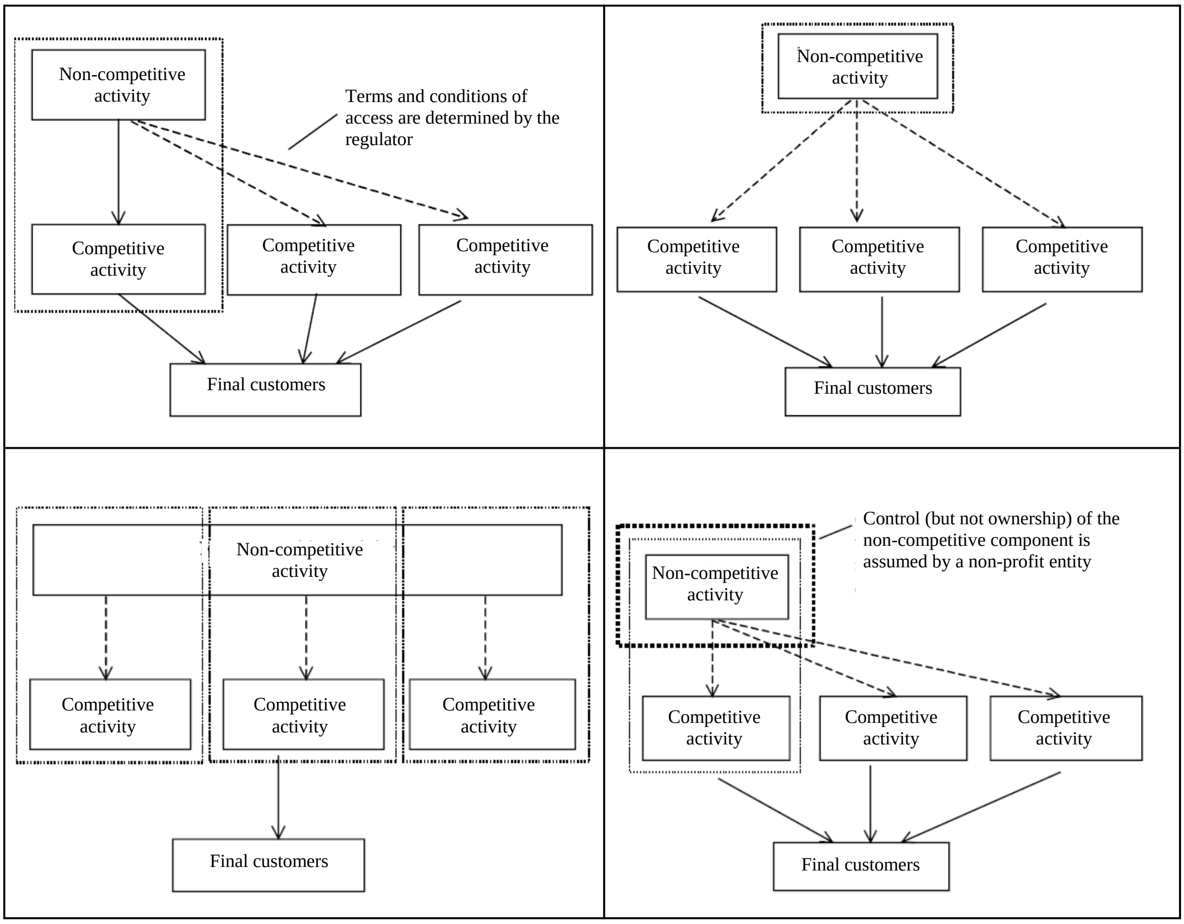
- *The vertical separation of the non-competitive activity and the competitive activity*: this tool eliminates all possible incentives that the owner of the non-competitive part may have to discriminate the competing companies that act in the competitive activity (see **figure A2.3**). This elimination softens the need for a regulation and increases the level of competition.

- *The club or joint ownership of the non-competitive activity by firms in the competitive component*: The club ownership consists of a structure where all competitive companies own a share of the non-competitive activity (see **figure A2.3**).

- *The operational separation (or unbundling) (separation of ownership and control, placing the non-competitive component under the control of an independent entity*): This tool is a hybrid of the tools presented in the previous points. The nature of this tool depends on the government structure that assumes the control of the non-competitive component. In case this entity should be dominated by the regulator, the operational separation will be analogous in a certain way to the access regulation. In case the governing entity should have representatives of the competitive firms, the operational separation will be in a certain way analogous to the separation of ownership (see **figure A2.3**).

- *The separation of the non-competitive component into smaller reciprocal parts*: This tool relies on the network effects to enhance interconnection. In the case of telecommunications, for instance, consumers are willing to pay more to be connected to a network where they can connect to more people.

FIGURE A2.3 ACCESS REGULATION, VERTICAL SEPARATION, SHARED OWNERSHIP, OPERATIONAL SEPARATION (FROM LEFT TO RIGHT AND TOP-DOWN)
Source: OECD (2001a)



- *The separation of the non-competitive component into smaller parts*: this tool allows establishing a series of companies with a similar distribution, facilitating the regulation of these companies through comparisons (known as “yardstick regulation” –regulation through norms or criteria–). It also facilitates competition among distribution companies, at least in the regions’ edges.

- *The accounting, functional and corporate separation*: In the first place, the accounting separation consists in the separate preparation of accounts, on the basis of predefined criteria, for some functions or specific services. On the other hand, the functional separation consists in separating different services into different divisions of the same company, possibly under a different management. Finally, the corporative separation consists in separating different services into different corporate entities, despite belonging to the same company. These three tools do not protect nor promote competition in themselves. However, they usually constitute an important supplement for other forms of separation, mainly for access regulation. This happens, for instance, because information at hand thanks to an accounting separation allows determining the access fees and detecting cross-subsidies.

Table A2.2 presents the pros and cons associated to each of the aforementioned tools.

TABLE A2.2 SUMMARY OF THE PROS AND CONS OF THE POLICIES TO PROMOTE COMPETITION
Source: OECD (2001a).

Policy	Pros	Cons
Access regulation	· Certain economies of scope from integration can be preserved · Avoids a costly separation	· Requires active regulatory participation · The regulator may not have enough information or instruments at its disposal to face all kinds of anti-competition behaviour · Need to control the capacity
Vertical separation of the ownership	· Eliminates the incentive for discrimination between downstream firms · Alleviates the need for regulation	· Potential loss of economies of scope from integration: may require a costly and arbitrary separation
Shared ownership	· Eliminates the incentive to discriminate and, therefore, reduces the need for active regulatory oversight and intervention	· The downstream rivals collectively have an incentive to deter new entrants · Requires some form of intervention if there is the possibility that new entrants will wish to join the “club” · Only valid in cases where the number of potential members of the club is strictly limited (such as the allocation of take-off and landing slots at an airport)
Operational separation (“operational unbundling”)	· Can facilitate the control of discrimination and anti-competition behaviours	· Possible lack of benefits reduces incentives to provide innovative and dynamic services
Separation into reciprocal parts	· Anti-competition behaviour is counteracted by the incentives to interconnect · Stimulates competition both horizontally and vertically · By allowing vertical integration, economies of scope are preserved	· Its usage is limited to certain industries, particularly those industries with two-way networks

The most suitable tool for each sector depends on a great variety of factors that, according to OECD (2001a), range from the magnitude of the economies of scale of the integration to the costs of separation, and also encompass the benefits and opportunities of the competition and the goals of the public policy for each industry.

Of the tools mentioned above, the two main approaches adopted to promote competition are:

- The *vertical separation of ownership*, that is, a structural approach that allows to reduce the incentives of the owner of the non-competitive component, to restrict competition in the component susceptible of being provided under a competition regime;

- The *vertical integration with access regulation*, a behavioural approach that requires a more restrictive regulation than the vertical regulation of ownership, in order to counteract the incentives of restriction to competition that the owner of the non-competitive component may have over the component susceptible to being presented in a competition regime.

A2.4.1.3. The reorganisation experience undergone by the network industries

In the two last decades, the *public utilities* have suffered significant changes, aimed at introducing competition in the competitive activities, and achieving the beneficial goals that its introduction implies (see section A2.4.1.2).

The introduction of competition has been basically done through the vertical separation of monopolistic companies, separating the activities susceptible to be provided in a regime of competition from the non-competitive ones, which are the ones that have kept natural monopoly features and for which a certain governmental intervention may be desirable. In other words, there has been a separation of the infrastructure (universal and common for all potential operators) from the operations or services of each industry, based on the separation of competitive and non-competitive components presented in **table A2.1**.

As a result of that, there has been a liberalisation of the network markets, leading to a reduction of state regulation and, as a side effect, an increased competitiveness between companies, a greater productivity and efficiency, and a price reduction.

Below the reorganisation undergone in some network industries (electricity, natural gas, air transport) in Europe is presented, emphasising the tools used to promote competition and the repercussions that its adoption has had on the market.

The reorganisation of the electricity sector

In the electricity sector, electricity generation, its provision and commercialisation in the market are considered activities potentially competitive. For that reason, the restructuring of the sector to promote competition can be done with:

- The separation of generation and transmission and distribution, for instance, through shared ownership or operational separation.

- The separation of supply and transmission or distribution, for instance, through shared ownership or operational separation.

- The separation of distribution and transmission.

On a European level, the chosen option has been to disaggregate the systems of transmission and distribution, as well as a gradual opening of national markets, both regulated by the European Directives 96/92/EC and 2003/54/EC. This last one has entailed the legal disintegration[24] of the operators of the transmission system and the operators of the distribution system from the rest of the industry, the free access to generation, the control of competition, the total opening of the market, the promotion of renewable resources, the reinforcement of the regulator's role and the introduction of a single European market.

The reorganisation of the natural gas industry

In the natural gas sector, as in the electrical industry, production and supply are activities susceptible of being provided in a competition regime. Thus, the promotion of competition in the natural gas industry is generally done through:

- The separation between production of gas and transmission/distribution.
- The separation between supply and transmission/distribution.
- The separation between gas storage and transmission/distribution.
- The separation between distribution and transmission.
- The separation between transmission/distribution of gas and generation of electricity.

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[24] For "legal disintegration" we understand, at least, the independence of the organisation and its decision processes, without the obligation of separating the ownership from the assets (EC, 2006).

In the framework of the European Community, the reorganisation of the sector is defined by Directive 2003/55/EC[25] on common rules for the internal market in natural gas, as well as by Regulation No 1775/2005[26] on conditions for access to the natural gas transmission networks.

Directive 2003/55/EC imposes the independence of the network management of gas transmission from the rest of activities not related to transmission, without forcing a separation between the ownership of the assets of the transmission system and the vertically integrated company, but forcing to an accounting separation. It also imposes the designation, by the Member States, of one or several competent organisms functioning as regulating authorities. This reorganisation would rather correspond to a vertical integration with access regulation.

The reorganisation of the air services sector

Traditionally, the organisation structure of the air services sector was formed by public companies of air navigation (also known as “legacy carriers”) that generally enjoyed the monopoly of air transport in the internal market and, backed by their respective governments, subscribed international agreements with other companies of the same nature in order to share the traffic developed between both countries, fixing the routes, frequencies and prices to be charged.

This turned the air transport market into a group of national markets, preventing the profits of the possibilities and advantages of a single market. Furthermore, it did not contribute to the European integration nor the development of closer relationships with other parts of the world. Therefore, this regulation system of air transport in Europe did not benefit the general interests nor the consumers’ ones. For that reason, the European Community decided to start a restructuring process of the sector, with the goal of introducing a greater degree of competition in the air markets.

At a world level, the main tool to promote the competition in the air market has been to vertically separate the operations of aircrafts and the infrastructural services, in particular (OECD, 2001a):

- The separation between the operation of the planes and the provision of airport services (such as the provision of slots for take off and landing).

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[25] Directive 2003/55/EC of the European Parliament and of the Council of 26 June 2003 concerning common rules for the internal market in natural gas and repealing Directive 98/30/EC.

[26] Regulation (EC) nº 1775/2005 of the European Parliament and of the Council of 28 September 2005, on conditions for access to the natural gas transmission networks.

- The separation between terminal facilities and other airport services, with each terminal station operated by an airline or group of airlines.

- The separation between land management service operation and other aspects of terminal services.

On a European level, the restructuring started in 1987 and was carried out in stages through the approbation of three packages of measures, with the goal of introducing a Single Sky policy (or common European air space). This policy aimed at allowing the transition from a highly regulated market to a single liberalised market, carrying out:

- *The liberalisation of the sector*, through the introduction of air transport policies (regarding prices, market access, capacity control and licensing for air carriers) and competition policies with the goal of protecting the competition from restrictive practices (such as for instance, public funding and traffic restrictions in the airports, among others).

- *The harmonisation of the norms* concerning safety, environment, transport responsibility, protection of the consumers when denied boarding, etc.

- *The establishment of a control system* of the capacity of airports and traffic.

- *The direction of exterior relationships* where the agreements of Community countries with other countries for the liberalisation of markets are postulated.

With the first package of measures, approved in December 1987 and in force since 1 January 1988, a first step was taken towards the liberalisation, thanks to the introduction of measures such as the limitation of the countries rights to object to the introduction of new prices, and measures which allowed for more flexible bilateral agreements. The measures of the first air package only applied to air transport regular lines among Community countries, domestic and international flights being excluded.

With the second package, approved in 1989, measures of transport policy and competition were introduced, which allowed increasing the liberties established in the first package regarding pricing and capacity allocation. The right to transport passengers from one’s own country to another, and vice versa, was also approved.

Finally, in 1992, a third air package was approved, in force since 1 January 1993. The package, which contained three regulations related to the concession of licences to the companies, the market access and services' fares, was the last stage of the progressive opening of the air sector. In fact, this last package gradually introduced the right to provide services in a free manner within the European Community, that is, it opened the market to the companies which owned a Community license. This package of measures culminated with the adoption of the right of cabotage in April 1997, which enabled operating a route in a foreign country without the need to stop over at the country of origin.

Nowadays, the European Commission is working on the revision of the third air package, because there are still some aspects pending liberalisation. Among others, one of these aspects are the prices, which are still very high for flights with flexible conditions.

The application of the packages of measures cited above has allowed the air European market to be governed by common laws regarding licences, market access and free establishment of fares. In fact, all airlines of the Member States of the European Common Aviation Area can operate with full traffic rights and no restrictions of capacity in any route of the Area.

The main consequences of the liberalisation of the air sector in the European sphere can be summarised in the four following points:

- *The increase in the number of companies and routes*, as a consequence of the emergence of competition due to the liberalisation of the sector. **Table A2.3** summarises the key indicators of the liberalisation of air transport in the European Union, among which we find the increase in the number of companies and routes experimented since the liberalisation of the air market. The increase in the number of routes is explained by the appearance of low cost companies, which thanks to their reduced costs make certain secondary routes viable, which would not happen under other conditions. Many of the new companies are regional companies based in secondary airports and allied with the big airlines.

- *The price reduction* as a consequence of the appearance of low cost carriers, which because of their special structure and working procedures offer very competitive rates, notably inferior to those of the conventional carriers. The price reduction has also been apparent in conventional carriers, which have introduced promotions with competitive prices but subject to a series of conditions, such as the purchasing of a return ticket. However, the prices of the flexible tickets, that is, the tickets which give total freedom to make changes or cancellations, have increased.

TABLE A2.3 LIBERALISATION OF AIR TRANSPORT IN THE EU: KEY INDICATORS Source: ICAO (2003).

	Pre-Liberalisation (before 1993)	**Year 2000**	**Change**
Number of EU scheduled airlines	124	131	6%
Number of EU domestic city-pair routes	813	910	12%
Number of domestic routes with more than on carrier	106	199	88%
Weekly seat on EU domestic routes (in thousands)	2.891	4.084	41%
Yearly ASKs on EU domestic routes (in billions)	73.000	105.000	44%
Yearly flights on EU domestic routes (in thousands)	1.486	2.220	49%
Share of EU domestic ASKs on routes with more than one carrier	34%	68%	+34ppts
Number of intra-EU (international) city-pair routes	692	1.202	74%
Number of intra-EU routes with more than two carriers	61	217	256%
Weekly seats on intra-EU routes (in thousands)	2.231	4.571	105%
Yearly ASKs on intra-EU routes (in billions)	102.000	243.000	138%
Yearly flights on intra-EU routes (in thousands)	1.109	2.080	88%
Share of intra-Eu ASKs routes with more than two carriers	42%	52%	+10ppts
No-frills airline share of total EU domestic ASKs	0,0%	3,9%	+4ppts
No-frills airline share of total intra-EU ASKs	0,6%	12,9%	+12ppts
Change in business class fares on routes within the EEA (nominal)	242€	350€	45%
Change in normal economy fares on routes within the EEA (nominal)	213€	243€	14%
Change in promotional fares on routes within the EEA (nominal)	147€	125€	-15%

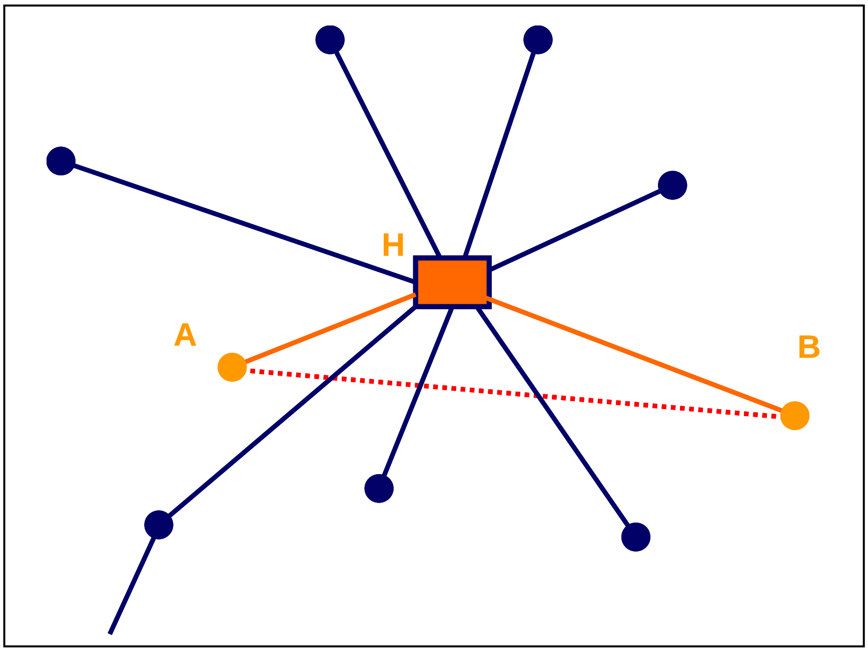
Notes:

- ASK: available seat kilometre (it measures the load capacity of a passenger transport dedicated carrier)
- ppts: percentage points
- EEA: European Economic Area

- *The restructuring of legacy carriers* in order to face the competition emerged from the liberalisation of the air market. The conventional airline carriers (legacy carriers) have adopted policies to increase their productivity and efficiency. Among them, two opposite policies, which nevertheless usually coexist in the same company, stand out. Firstly, the adoption of policies similar to those of the low cost carriers, such as not emitting tickets or the imposition of restrictions in ticket changes or refunds. On the other hand, the adoption of differentiation policies, which accentuate the differences between both types of operators (for instance, a greater comfort for the passenger, greater flexibility of the ticket, better onboard and airport services) to maintain a certain type of clientele willing to pay more to receive a better service. In some cases, the restructuring also includes structural measures such as the Hub & Spoke system. This measures consists in concentrating the traffic in a single destination of central localisation (called “hub” airport), so all the flights from and towards other cities pass through the Hub (see **figure A2.4**). This allows for the reduction of the number of direct routes and the use of planes with bigger capacity, increasing the load factor of the planes and their frequencies, and favouring the appearance of economies of scale.

- *The consequences on other modes of transport*, such as road transport or high speed railway transport, consisting in a transfer of passengers towards aviation, forcing the competitors to adapt their pricing or commercial policies in order to compete with the air sector after the liberalisation.

FIGURE A2.4 HUB & SPOKE SYSTEM



A2.4.1.4. Balance of the restructuring of "public utilities" other than railways

The balance of the restructuring of telecommunication, electricity, natural gas and air transport industries is, on the whole, positive.

In the case of the air sector, the most interesting one in the context of this dissertation because it also belongs to the transport sector, the system reorganisation has promoted innovation and initiatives that have resulted in an increased routes' offer and a greater competition within existing routes. In some cases, they have succeeded in attracting clients from other modes, such as railways.

These positive results of network industries restructuring are reassuring for the railway sector, currently in the middle of a reorganisation process. In the following sections we show how this process is being carried out, which are the motivations to put it forward, and what situation it has given rise until now.

A2.4.2. Separation between rail infrastructure management and operation

Among the tools available to revitalise railways in Europe, the EU has opted for the vertical separation between infrastructure management and service operation as a previous condition to opening the markets and introducing competition, following a similar pattern to the ones adopted in other network markets.

The motivations behind the choice of a separation in the European railway field are presented in the following section.

A2.4.2.1. Reasons for a separation in the railway field

In the last twenty years, the traditional railway premises presented in section A2.1 have undergone a notable change mostly due to the development experienced by other means of transport (road, aviation), as introduced in annex A1.

During the 1990s, as shown in section A2.3, railways in Europe started to reorganise their traditional structure in order to improve their efficiency. However, the introduction of business units that allowed a functional classification and an operation territorial division system in services supplanting the previous unitary and integrated organisation of all activities was not enough, according to some authors, to provide enough incentives to railway companies.

In 1996, CEMT (1996), in the conclusions of the Round Table 103 held in Paris, affirmed that “a transformation or a radical reform of the way in which railways were organised was inevitable in many senses, especially if the goal was to find a solution to the economical difficulties that paralysed most European railways as a result of their lack of commercial dynamism and low productivity”.

Thus, this situation of decline of railways in Europe in the 1990s, both in economic deficit and market share terms, led the European Commission to publish, in 1996, a white paper entitled “A strategy for revitalising the Community’s railways” (CE, 1996). This white paper responded to the need of defining a strategy in order to revitalise Community railways, reorganising their economic situation, guaranteeing free access to traffic and public services as a whole, and promoting national networks integration and social aspects.

Five years later, a new white paper was published, “European Transport Policy for 2010: Time to decide”, with the goal of conciliating economic development and the demands of a society that requires quality and safety in order to foster modern and sustainable transport (CE, 2001a).

These publications show the motivation of the European Commission to modify the traditional organisation of railways, in order to modernise them.

Free access guarantee to traffic and public services as a whole, mentioned in the White Paper of 1996, required the separation between infrastructure management (the case of a natural monopoly) and railway services operation (a competition-prone activity), because the vertical separation is, according to Obermauer (2001), an indispensable precondition to allow a non discriminatory access to new railway companies.

With the goal of determining the long-term advantages that could be derived from separation between railways infrastructure management and operation, the European Conference of Ministers of Transport (ECMT) organised, in June 1996, a round table on this subject. The conclusions reached are summarised in **table A2.4.**

On the other hand, the separation of railway infrastructure and operation should enable, according to CEMT (2005):

- *Rationalising internal and international transport and taking the social costs of transport into account*: These two objectives (rationalisation and social benefits) seem to be the main preoccupation of the European Union and fuel the action of the European Commission not only in the transport sector, but also in every other field.

- *Clarifying the role of public support to railways and fostering the development of competition in railways*, especially on an international scale, and dismantling the old national border obstacles that hinder operators (infrastructure obstacles are less important as long as they do not prevent international traffic).

TABLE A2.4 ADVANTAGES AND DISADVANTAGES OF THE FRAGMENTATION OF RAILWAYS UNIVERSE

Source: Author's elaboration from CEMT (1996), Bergougnoux (2000), Petrantonio et al. (2004), Directorate for Financial and Enterprise Affairs (2005) and EC (2006).

Advantages	Disadvantages
- The tendency to specialise in the own competence field, and subcontract functions or tasks to the most efficient company, allows a significant **improvement of productivity**.	- The fragmentation of responsibilities can have consequences on **operation safety**. For this reason, it will be necessary to do a specific planning and reflection, in order to counteract the lack of a "global vision", found in the integrated railway companies.
- The **competition** among companies should stimulate technical, organisational and commercial innovation, and therefore connect railway performances to the needs of the client.	- **Solving conflict situations** (delay of a train or perturbations due to different reasons) can become extremely complex. In fact, it can lead to companies revising the contractual clauses initially agreed.
- It increases cost **transparency**. This facilitates the competitive access and creates incentives for an efficient cost recovery, an improvement of capacity allocation and a maximum infrastructure use costs recovery. It also facilitates State subsidies allocation (an essential argument in favour of an accounting separation).	- **Loss of promotion opportunities for the staff** on the whole of the tasks susceptible to develop in an integrated company, as a result of having to depend on a highly specialised company with strictly limited tasks (rail maintenance, etc.).

Advantages	Disadvantages
- The separation between infrastructure management and operation allows for a non discriminatory access to the network, that is, the **neutrality** towards all operators, since it reduces the incentives that infrastructure owners may have to restrict access to rival companies in competitive markets.	- **Economical risks** linked to the risk that the infrastructure manager-owner may be in a situation of monopoly that can lead it to be economically weak. For instance, if it is connected to public authorities, its losses will be covered and it will not be forced to dynamise its management.
- **It favours the privatisation of commercial activities** of the industry (generally, the privatisation of the competitive segments of the sector increases efficiency).	- **Risk of insufficient investments in infrastructure**: The conservation of ties with the public protection by the infrastructure manager will always force it to overrate investment needs that he will present to public authorities.
- The greater independence of network management and financing ensures that the decisions are made in the interest of the network (reliability)	- **Loss of economies of scale** that result from the integrated execution of several activities in a railway company.
	- **Transition costs** derived from the restructuring.

- *Providing the infrastructure supplier with economic stability*: The European Commission has acknowledged that it is necessary to choose between the socially optimal access charging principle (charging based on social marginal cost) and the necessary financial stabilisation of the infrastructure supplier (by revenue perception integrally covering financial costs). It has also ascertained that certain Member States are not prepared to mobilise public capital in order to cover the difference between social marginal cost and global financial costs and has therefore accepted that the charge be increased (see chapter 1 for more information on the subject).

- *Underlining the company*: The European Commission has specifically conferred the title of “company” to the infrastructure supplier and to operators. The structural split of railways clarifies the functioning of each one of its components and should place each of them in a position of better focusing on the needs of every particular market.

- *Mobilising private investment*: The European Commission does not take sides in favour of privatisation nor remaining in the public field, but it is clear that Community railways will have to face a hard competition from private companies of road and inland navigation transport, as well as low cost carriers (in the particular field of freight transport and long distance passenger transport). The functioning of railways in different elements, each focused towards its particular market should reinforce the competitive capacity of each of these elements, and provide even more possibilities of orienting private investments in a convenient direction.

Due to the advantages derived from a possible separation between infrastructure and operation in railway services and with the preoccupations mentioned above, the European Union (EU) took another step towards the separation between rail infrastructure management and operation (Directive 2001/14/EC), discreetly initiated in Europe with Directive 91/440/EC, which marked the first stage in the reform of European railway systems.

The theoretical framework of this separation between management and railway operation is presented in the following section.

A2.4.2.2. Theoretical framework of the separation. The Directives of the European Commission.

The theoretical framework of the European railways separation is defined by a series of directives approved by the European Commission between the 1990s and the first decade of the 21st century (see section A2.2), which mark the EU railway reform lines.

The European directives that regulate this separation of the infrastructure and railway operation in the European Union have been summarised in the **table A2.5.**

TABLE A2.5 LEGISLATION OF THE EU APPLICABLE TO THE RAILWAY SECTOR, RELATIVE TO MARKET ACCESS AND INFRASTRUCTURE

Original directive	Modification of the original directive
✓ Directive 91/440/EEC	- Directive 2001/12/EC - Directive 2004/51/EC - *Corrigendum* to Directive 2004/51/EC
✓ Directive 95/18/EC	- Directive 2001/13/EC - Directive 2004/49/EC - *Corrigendum* to Directive 2004/49/EC

Original directive	**Modification of the original directive**
✓ Directive 95/19/EC	- Directive 2001/14/EC - Commission decision 2002/844/EC of 23 October 2002 amending Directive 2001/14/EC in respect to the date of changing the working timetable for rail transport - Directive 2004/49/EC - *Corrigendum* to Directive 2004/49/EC

Directives 91/440/EEC, 95/18/EC and 95/19/EC, which herald the start of the European railway sector liberalisation process, determined the necessity and obligation of introducing an accounting separation between infrastructure and operations. In particular, Directive 91/440/EC said (Article 4 of Section II – Management independence of railway undertakings) that:

> *"Member States shall take the measures necessary to ensure that as regards management, administration and internal control over administrative, economic and accounting matters railway undertakings have independent status in accordance with which they will hold, in particular, assets, budgets and accounts which are separate from those of the State".*

With this measure, compulsory from the accounting year 1995, the EU wanted to achieve a total transparency and comprehension of different cost concepts: the costs relative to public service obligations; the non recoverable costs for the construction of infrastructure; maintenance costs; and infrastructure management and train-path allocation costs.

This first directive on the separation of railway infrastructure did not demand to explicitly separate infrastructure and operations in different companies.

A few years later, Directive 2001/12/EC modified Directive 91/440/EEC on the development of Community's railways, providing extra contents and introducing significant modifications, among them the extension of its contents relative to the separation of accounts of transport services operation provided by railway undertakings and infrastructure managers. On this subject, in its Article 6, Directive 2001/12/EC says:

> *"Member States shall take the measures necessary to ensure that separate profit and loss accounts and balance sheets are kept and published, on the one hand, for business relating to the provision of transport services by railway undertakings and, on the other, for business relating to the management of railway infrastructure. Public funds paid to one of these two areas of activity*

> *may not be transferred to the other. The accounts for the two areas of activity shall be kept in a way that reflects this prohibition”*.
>
> *“Member States may also provide that this separation shall require the organisation of distinct divisions within a single undertaking or that the infrastructure shall be managed by a separate entity”*.

Therefore, with the approbation of Directive 2001/12/EC, the European Union proposed three models of separation, the application of the first one of which was compulsory. These three models are:

- *Accounting separation*: It is the separation imposed by Directive 91/440/EEC to the European Union countries. It consists in the accounting separation between the activities related to infrastructure management and the activities related to the operation. This separation enables knowing the railway infrastructure management unitary costs in each country. These costs have to be the basis to establish a charge for the use of the tracks, equal for each one of the members.

- *Organisational separation (operational separation or holding separation)*: (also known as “integrated model”): In this separation, separated business units with a high degree of operational freedom are created. In this case, business units may operate either as a part of a railway undertaking (that is, they may have separated management and balance without having legal autonomy), or as autonomous business units within a holding company.

- *Institutional separation*: The institutional separation is considered the real separation, because in this model “the owner of the infrastructure and railway undertakings are separated into separate autonomous entities with capitalisation, balance sheets and staff” (Profillidis, 2001). In the institutional separation, even when the infrastructure manager is public, the rules and laws that regulate private companies must be followed. In this structure there is a governmental regulator that mediates the disputes between the owner of the infrastructure and railway undertakings.

On the other hand, Directive 2001/12/EC introduced the figure of the “Infrastructure Manager” (IM), understood as “any body or undertaking responsible in particular for establishing and maintaining railway infrastructure” (CE, 2001b). It also assigned to an independent body the functions determining equitable and non-discriminatory access to infrastructure.

This equitative and non-discriminatory access for all railway undertakings was reinforced by Directive 2001/13/EC, amending Council Directive 95/18/EC, on the licensing of railway undertakings. This new Directive tried to generalise the concepts of licensing to all active companies of the sector[27].

The contents of Directive 2001/14/EC are analysed in chapter 1, because it mentions the introduction of the charge for the use of railway infrastructure, a consequence of the process of reorganisation and vertical separation of the railway sector.

In the following section the situation that has given rise to the application of the theoretical framework of the separation in the EU is analysed.

A2.4.2.3. Present state with regard to the separation between management and operation in the European railway field

The application of the EU normative in relation to the separation between management and operation in the European railway field has resulted in two standard structural models, and a third one placed in between (see **figure A2.5**). Namely:

- *Integrated model*: This model results from the organisational separation (or holding separation), characterised by a combination of accounting separation and access regulation. In an integrated model, the railway undertaking (RU) and the infrastructure manager (IM) are legally separated entities that work together in the same common holding structure or that are part of a same company. The other RUs can compete by means of standard contracts with the IM of the integrated company, on the basis of a non-discriminatory access regulated by a regulatory body and/or a competence authority. Because European law requires the separation of RU's and IM's accounts that compose an integrated model of railway organisation, the existing financial flows between the operator and the manager in an integrated company have to be transparent in the annual accounts.

- *Separated model*: This model results from the institutional separation. It introduces a real vertical separation between the entities responsible for the competitive components and the entities responsible for the non-competitive components of the railway industry. In this model, the infrastructure manager hires independent

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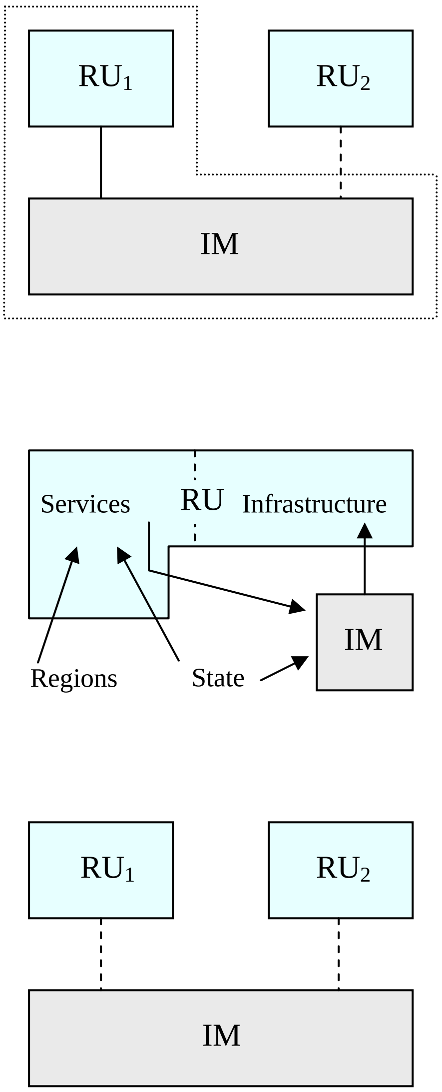
[27] The companies that provide urban and suburban passenger transport services, or in isolated local and regional networks, were excluded from the scope of this directive. The companies that operate regional freight transport services or the ones that develop their own freight transport operations in a network exclusively designed for that end were excluded as well (CICCP, 2006).

railway undertakings, which provide the operation of the service, because the IM cannot directly supply the transport services.

FIGURE A2.5 STANDARD STRUCTURAL MODELS OF SEPARATION BETWEEN MANAGEMENT AND OPERATION IN THE EUROPEAN RAILWAY FIELD



Integrated model

- The area delimited with dotted lines represents the holding structure or the company that encompasses both operation and management activities.
- The link between RUs and the IM belonging to the holding has been drawn with a continuous line because the Managing Director of an integrated company, facing competition in operations, can ensure that the IM works under commercial pressure to serve clients (without remaining a bureaucratic administration under the direct influence of the Minister of Finance of the government).

Partially separated model

- The partial separation is an institutional separation although in fact it works almost as an integrated company.

Separated model

- There are many variations of this basic structure, especially with regard to the property.

RU: Railway Undertaking
IM: Infrastructure Manager

- - - - - - - Link by means of a contract
——— Link between companies of a single holding

- *Partially separated model (or hybrid system)*: This model is still a separation model (institutional separation), although in fact it almost operates as an integrated company. At an operational level, the railway system is indeed integrated, because the RU still owns the network, as well as the network traffic management and operation. However, the maintenance and the management functions are carried out by means of a contract of a completely separated IM that owns the infrastructure and is responsible for the network development.

Nevertheless, there are several variations on the basic models (integrated and separated models), especially with regard to the property, since the European Commission does not venture into this subject[28].

With regard to the *integrated model*, the following variations are found:

- Case where *the company is mainly of private ownership* (e.g. Estonia).

- Case where *the Government is the only shareholder of the integrated company* (e.g. in Switzerland there are two integrated public ownership companies, with their respective railway undertakings competing in their own network and in other networks).

Concerning the *separated model*, these are the cases that can be found:

- *Exclusive operation of private ownership railway undertakings*, both in passenger and freight markets (e.g. the United Kingdom).

- *Existence of at least one public passenger or freight operator* (e.g. the rest of European countries). In this case, the competition in the network is provided by other operators under private or public ownership.

The situation of the European countries on the basis of the models previously presented is summarised in **table A2.6**.

This diversity of practices in the European railways organisation field shows that the debate on integration versus separation is still much alive in Europe. The main arguments used by different countries to adopt either one or another of the models are summarised in **table A2.7**. In spite of this, the EU liberalisation aspirations reflected in Directives

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[28] Article 222 of the Treaty of Rome says that "This Treaty shall in no way prejudice the rules in Member States governing the system of property ownership".

2001/12/EC, 2001/13/EC and 2001/14/EC "indicate that in a near future the institutional separation will be compulsory in the countries of the Union" (Ramos Melero, 2002).

TABLE 3.6 RAILWAY MODEL INTRODUCED IN DIFFERENT EUROPEAN COUNTRIES
Source: Author's elaboration from NERA (2004), Calthrop (2005), Thompson (2005a) and EC (2006).

Structure		Property	
		Public	Private
↓	**Integrated**	Austria Belgium Switzerland Germany Greece Italy Latvia Hungary Poland	Estonia
	Partially separated	France Czech Republic Slovenia Estonia Hungary	
	Separated	Denmark Spain Finland Lithuania Norway Netherlands Portugal Slovak Republic Sweden	United Kingdom

Remark:

- The arrow indicates the direction promoted by the European Commission, which has opted for the companies to go from an integrated structure (top of the table) to a separated structure (bottom of the table).

It is important to mention that the degree of separation (or integration) constitutes a good indicator of the market's competition, because, as previously seen, the separation between infrastructure management and operation is a tool that promotes competition.

TABLE A2.7 ARGUMENTS FOR AND AGAINST EACH STRUCTURAL MODEL OF SEPARATION BETWEEN MANAGEMENT AND OPERATION
Source: Own from Obermauer (2001) and Calthrop (2005).

Integrated model		Separated model	
Arguments for	**Arguments against**	**Arguments for**	**Arguments against**
A single management structure at a company or holding level ensures a higher degree of coordination between the IM and the RU than any other contract can provide. Therefore, it ensures the long term development of the railway system as a whole.	It constitutes a substantial barrier for competition, because it is not sensible to market services demands.	It is the simplest structure capable of ensuring the non-discrimination by the IM when dealing with the different RUs.	The government still acts as a link between the public RU and the public IM.
If the integrated company is subject to the competition in operations, it can be affirmed that the IM works under commercial pressure to serve its clients (without remaining a bureaucratic administration under the direct influence of the Minister of Finances of the government).		It promotes efficiency and adapts to market needs.	It hampers the elaboration of timetables, train-path allocation and planning.

A2.4.2.4. Organisational situation of the railway field outside Europe

Although in Europe, in recent years, the separation between infrastructure and operation as a tool to introduce competition in the railway market has prevailed, it is surprising that in the rest of the world almost every railway is integrated and that in some cases they belong to private hands.

The restructuring process of railways undergone in the United States and Japan is summarised in the following sections. This process started with the same goal as the reorganisation of European railways: to revitalise the railway mode, improving the economical situation of the companies and introducing competition into the sector.

Railway reform in the United States

If railways in Europe were in a situation of decline at the end of the 1960s because of the development of high performance road infrastructures (motorways) and of the plane in medium and long distance journeys, as seen in annex A1, in the United States this was already happening in the mid 1950s. By the 1970s, the railway system was considerably enfeebled and many railways were on the brink of bankruptcy.

To stop the decline and to revitalise intercity passenger railway services, the Rail Passenger Service Act of 1970 created the public company National Railroad Passenger Corporation (Amtrak). With its creation, the Government decided to nationalise the passenger railway market sector, with the goal of increasing the service standards, which had declined due to the strong competition of both the plane and the automobile. With this action the Government wanted to ensure the viability and expansion of long distance passenger railway transport, performing at the same time a restructuring and an adjustment of the existing resources. On the other hand, with the creation of Amtrak, the private railway industry liberated itself from a big share of the economical losses derived from passenger trains operation.

But the creation of Amtrak did not solve railways delicate situation: while in 1972 Amtrak’s market share was 0,8% of all passengers who did long and medium distance travels, in 1997 it had fallen to a meagre 0,4%.

As a result of that, in the 1990s Amtrak found itself in a precarious financial state, and was highly dependant on operation funds and federal capital. To make matters worse, between 1991 and 1997, the number of passengers transported by Amtrak decreased by 10%, while that of aviation increased by 28%.

According to Vranich (1997), Amtrak’s failures were mainly due to the fact that the company was a public monopoly, “the type of organisation less inclined to innovate”. In any case, Amtrak operated routes that responded to political needs but not to market demand, so it did not earn enough money to pay the operation expenses and lost disproportionate quantities of money in the long distance trains.

For that reason, the Working Group on Intercity Rail, created in 1997 by the *House Transportation and Infrastructure Committee*, considered that Amtrak monopoly should terminate and that it was time to open passenger railway service to competition. Along these lines, the Congress passed the Amtrak Reform and Accountability Act of 1997, which established that if by December 2002 Amtrak was not financially self-sufficient, the company should be restructured and liquidated. Given the case, “an action plan to restructure and rationalise the intercity passengers railway system” should be delivered to the Congress, and "Amtrak should deliver a plan for its complete liquidation" (Vranich et al., 2001).

Between 1998 and 2000, Amtrak received 3.910 million dollars, more subsidies than in any other three-year period in its thirty years of existence. In spite of this, Amtrak did not manage to be financially self-sufficient. For this reason, in April 2005 Amtrak explained the initiatives for its strategic reform (Amtrak Strategic Reform and Initiatives and FY06 Grant Request, Amtrak, 2005). In particular, it proposed the creation of five business lines: long distance trains, short distance trains, Northeast Corridor operations (NEC), NEC infrastructure and auxiliary business (in particular operation contracts of suburban trains outside the NEC).

In relation to railway freight transport, in 1970 the six railway companies of the East, which were facing bankruptcy, were nationalised and merged into a new company under the name Conrail. On the other hand, between 1979 and 1982, air, truck and railway transport were deregulated. The railways deregulation took place in 1981 with the decree known as "Staggers Act", which significantly reduced the governmental participation in fare-setting and railway freight transport services. The developments were positive, and by the 2000s railway freight transport was profitable again, although at a lower level than other industries. Therefore, it may be said that the deregulation and state financing turned Conrail into a profitable company, which was sold to private hands in 1987.

To summarise, the American model is characterised by a distinct treatment between:

- *Long distance passenger services*: Managed by the public company Amtrak, subsidised both by the federal government and the states of the Union.

- *Freight services*: Managed by more than 500 private railway companies, although 90% of the market is divided among seven companies, known as the "super seven". The railway freight companies integrate in their ownership the network and terminals, and they have running and freight transport regulation functions. In every case, these companies guarantee the free circulation of other companies provided they pay a charge for the use of the tracks.

- *Suburban services*: These services are managed by public companies or mixed ones with public subsidies, generally from the corresponding local entities.

The reforms performed in order to improve the situation of American railways, and which led to the railway model summarised in the previous paragraphs, were, according to

Thompson (2005b):

a) Eliminating cross subsidies, directly paying the economical aids to the passenger services operator (Amtrak).

b) Encouraging competition and improving service through the transport sector deregulation.

c) Leaving freight operators and infrastructure within the private sector, with the goal of keeping railways and trucks in the same competitive basis.

d) Adopting a pragmatic and mixed approach, regarding ownership and structure. Therefore, freight railways are under private ownership and managed by private companies, with little public participation. On the other hand, Amtrak, the passenger services operator, is a public company, financed with public funds.

Railway reform in Japan

The development of high performance road infrastructures also had negative repercussions on the Japanese railways market share. In this case, the Japanese National Railway (JNR), created in 1949 as a public company in charge of both the railway services management and operation, started to suffer losses in 1964, which raised the necessity of undertaking a reform in the railway transport field.

Between 1964 and 1979 there were several failed attempts of reform. Finally, in 1981 the Government constituted the Second Ad Hoc Commission on Administrative Reform in order to stop the significant losses of JNR. This Commission decided to create the JNR Reform Commission in 1983, which issued a series of recommendations in 1985. As a result, in May 1986 two laws were passed, the JNR Reform Act, and an Act concerning Passenger Railway Companies and JR Freight. This reform, which was purely financial, marked the separation and partial privatisation of the old Japanese National Railway (JNR).

In particular, the JNR Reform Act statutorily dissolved JNR in April 1987, and its assets, operations and debts were distributed among new companies conforming a new business group, known as Japan Railways Group, JRs. The distribution of the infrastructure, the assets and the activity of passengers JNR was made following geographical criteria. In particular, it was divided into six private regional companies: three in Honshu Island (JR Higashi Nihon or JR East; JR Tokai or JR Central; JR Nishi Nihon or JR West) and one in each of Hokkaido (JR Hokkaido), Shikoku (Shikoku) and Kyushu (JR Kyushu) islands. For railway freight transport, a single company of national scope was created, under the name of JR Kamotsu (or Japan Freight Railway Company). Therefore, there was a regional separation and a vertical integration of the railway passengers companies.

Besides the six companies mentioned above, the Shinkansen Holding Company was created for the main island (Honshu Island), a governmental entity that owned the high speed railway infrastructure and inherited part of the debt of the old JNR. The debt had to be amortised with the revenues obtained from leasing the infrastructure to the three new private companies that operated in Honshu Island. However, nowadays the infrastructure belongs to the three JRs of the island, because the Shinkansen Holding Company transferred it to the JRs after being dissolved. For the lines of the three smaller islands a management stabilisation fund was created in order to help the three private companies that operated them amortise part of the JNR debt that was transferred to them. Finally, a liquidating corporation was also created, Settlements Corporation, which absorbed all JNR's rustic and real-estate goods, all the workers who did not want to join the new private companies, and a great part of the debt that the old state company had incurred. This volume of debt had to be amortised through the exploitation of transferred properties and goods and the sale of shares of the JR group.

On the other hand, the Railway Companies Act allowed railway companies to adopt the functions of one of the three types of company defined by it:

- *Type 1 company*: All the companies which own railway infrastructure and operate trains like it was traditionally done, were defined as Type 1 companies.

- *Type 2 company*: The companies that only do operation tasks were defined as Type 2 companies.

- *Type 3 company*: The companies that only own infrastructure belonged to this type.

Therefore, this Act allows railway infrastructure operation and ownership to be divided between Type 2 and Type 3 companies, respectively. This model differs from the European Union model because in the European countries where ownership and operation are separated the railway infrastructure belongs to public entities, which do not have to refund construction costs. On the contrary, Type 3 Japanese companies have to refund construction costs to Type 2 companies through charges for the use of infrastructure.

Under this Act, the six JR's railway passenger transport companies were defined as Type 1 companies, and the railway freight transport company, JR Kamotsu, as Type 2 company.

Therefore, JR companies are vertically integrated companies, with the exception of JR Freight.

After the separation of JNR, the next step was the privatisation of the companies of the new JR group, which constituted the fundamental goal of JNR dissolution. Between 1993 and 1999, private investors bought 87% of JR East, and the remaining 13% was sold in 2002. On the other hand, in 1996 JR West sold 68% of the company, and in 2004 they sold the remaining 32%. The sale of JR Central started in 1997 with 60% of its shares, the rest being completed in 2006.

The reform presented in the previous paragraphs constitutes the biggest railway reform that has taken place in the world since World War II. Its results are positive, given that since the restructuring of the old Japanese National Railways and the privatisation of railway passenger transport companies, the biggest railway companies (JR East, JR West and JR Central) have been profitable, and most of their shares have been sold to private investors.

Remarks

In the previous paragraphs, it has been showed that there is no single reform model to revitalise railway markets: while the European Union has chosen a system aiming at free access to railways, requiring (at least on the accounting field) the separation between infrastructure management and operation, in the United States and in Japan a model of vertical integration has been followed, with ownership and interconnections.

So, while Europe is following a path towards the dissolution of railway monopolies, in Japan the reform has culminated in the creation of regional vertically integrated monopolies with interconnection and measures that promote free access[29], but do not strive to introduce competition in the market, at least in medium and short distance journeys. Similarly, in the United States the model of vertically integrated companies, where railway companies must offer free (and equal) access to their competitors, also prevails.

Other reform options have been adopted in other countries. One of them is the option of considering vertically integrated long term concessions, based on concessions to regional monopolies for long periods of time, of around 30 years, for instance. Examples of this measure can be found in countries such as Argentina and Brazil.

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[29] Japan has vertically separated its freight services and vertically integrated its passenger services.

These three models have positive and negative effects. For that reason it cannot be affirmed that any of them is the best *per se*.

ANNEX A3

RAIL CHARGING DATABASE

RFF – Réseau Ferré de France
Gestionnaire des Infrastructures Ferroviaires

FRANCE

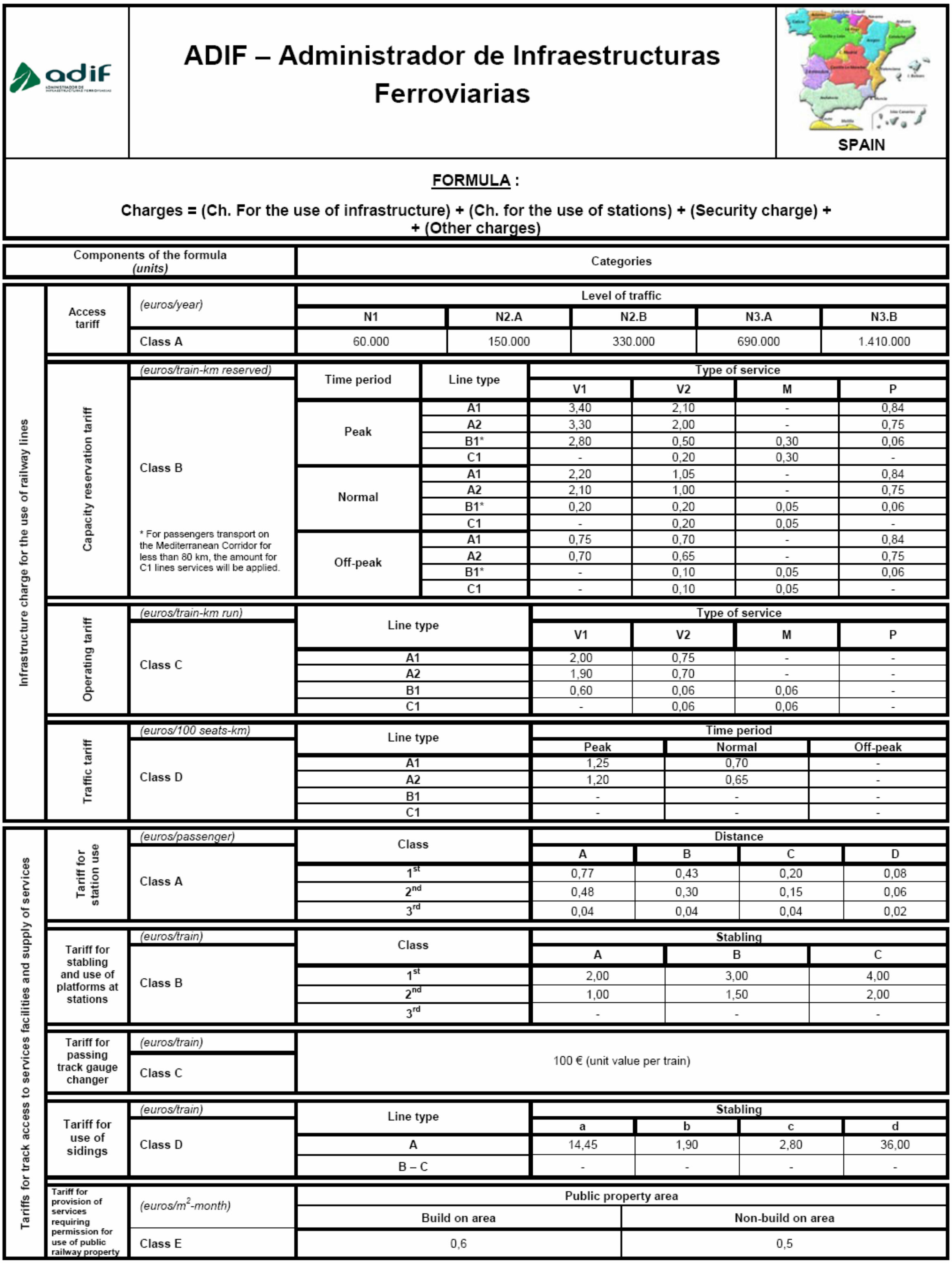
FORMULA :

Infrastructure charge = (Charges for minimum services) + (Charges for access to equipment) +
+ (Charges for additional services) =

= (Access charge + Path reservation charge + Reservation charge for stops at stations + Running charge) +
+ (Charges for access to equipment) + (Charges for additional services)

Components of the formula *(units)*						Categories											
Charges for minimum services	**Infrastructure characteristics**	**Access charge (DA)**			*(Unit price in € ex. VAT)*	**Suburban lines**		**Main intercity lines**				**High-speed lines**					**Other lines**
						A	**B**	**C**	**C***	**D**	**D***	**N1**	**N2**	**N2***	**N3**	**N3***	**E**
					DA	0,015	0,015	0,015	0,015	0,000	0,000	0,946	0,946	0,946	0,946	0,946	0,000
		Charge for reservation of capacity	**Path reservation charge**		*(Unit price in € ex. VAT)*	**Suburban lines**		**Main intercity lines**				**High-speed lines**					**Other lines**
						A	**B**	**C**	**C***	**D**	**D***	**N1**	**N2**	**N2***	**N3**	**N3***	**E**
				DRS	Off-peak hour	1,550	0,650	0,650	0,650	0,010	0,010	5,366	1,255	1,255	0,896	0,896	0,000
					Normal hour	4,970	1,244	0,650	0,650	0,050	0,050	10,739	2,949	2,949	1,894	1,894	0,005
					Peak hour	14,300	3,280	1,250	1,250	0,050	0,050	12,870	5,586	5,586	3,565	3,565	0,005
					Modulating Coefficient freight and light running	0,6 Remarks : - In categories C* et D* train-paths for high speed passenger trains pay tariff N3 - The modulation coefficient is not applied to freight train-paths whose length is equal or higher than 300 km and its mean speed (without taking into consideration the stops requested by the operating company) is equal or higher than 70 km/h.											
			Reservation charge for stops at stations (DRAG)		*(Unit price in € ex. VAT)*	**Suburban lines**		**Main intercity lines**				**High-speed lines**					**Other lines**
						A	**B**	**C**	**C***	**D**	**D***	**N1**	**N2**	**N2***	**N3**	**N3***	**E**
				DRAG Passengers	Off-peak hour	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
					Normal hour	7,200	5,500	5,500	5,500	5,500	5,500	7,200	5,500	5,500	5,500	5,500	5,500
					Peak hour	24,350	21,200	21,200	21,200	21,200	21,200	24,350	21,200	21,200	21,200	21,200	10,000
	Traffic characteristics	**Running charge (DC)**			*(Unit price in € ex. VAT)*	**Suburban lines**		**Main intercity lines**				**High-speed lines**					**Other lines**
						A	**B**	**C**	**C***	**D**	**D***	**N1**	**N2**	**N2***	**N3**	**N3***	**E**
					DC National Passenger trains	0,944											
					(Unit price in € ex. VAT)	**Suburban lines**		**Main intercity lines**				**High-speed lines**					**Other lines**
						A	**B**	**C**	**C***	**D**	**D***	**N1**	**N2**	**N2***	**N3**	**N3***	**E**
					DC Regional Passenger trains	0,806											
					(Unit price in € ex. VAT)	**Suburban lines**		**Main intercity lines**				**High-speed lines**					**Other lines**
						A	**B**	**C**	**C***	**D**	**D***	**N1**	**N2**	**N2***	**N3**	**N3***	**E**
					DC Freight trains and light running (HLP)	0,3											
Charge for access to equipment	**Passenger stations**					62.589,20 € ex. VAT											
	Freight stations																
	Marshalling yard					43.716,56 € ex. VAT											
	(€/electric train-km)					**Transport of electricity by**											
						High-speed national trains	**Other national passenger trains**	**Regional passenger trains, Île de France**	**Other regional passenger trains**	**Freight train**	**Other trains (HKP, material, ...)**						
	Electric traction facilities					0,442	0,317	0,433	0,219	0,36	0,074						
	Building sites of formation of trains					See list 1 of appendix 10.2 of the Network Statement											
Charges for additional services	**Execution of studies for exceptional consignments and consignments of dangerous goods**					Amount fixed by a particular contract concluded with the railway company											
	Prolonged stabling on holding sidings					10,61 € ex. VAT											
	Traction current					0,214 €/electric train-km											

Source: Sánchez-Borràs from RFF's Network Statement
(Valid from 11.12.05 to 09.12.06)



ADIF – Administrador de Infraestructuras Ferroviarias

SPAIN

FORMULA :

Charges = (Ch. For the use of infrastructure) + (Ch. for the use of stations) + (Security charge) + + (Other charges)

Components of the formula *(units)*	Categories

Infrastructure charge for the use of railway lines

Access tariff

(euros/year)	Level of traffic				
	N1	N2.A	N2.B	N3.A	N3.B
Class A	60.000	150.000	330.000	690.000	1.410.000

Capacity reservation tariff

(euros/train-km reserved)	Time period	Line type	Type of service			
			V1	V2	M	P
Class B	Peak	A1	3,40	2,10	-	0,84
		A2	3,30	2,00	-	0,75
		B1*	2,80	0,50	0,30	0,06
		C1	-	0,20	0,30	-
	Normal	A1	2,20	1,05	-	0,84
		A2	2,10	1,00	-	0,75
		B1*	0,20	0,20	0,05	0,06
		C1	-	0,20	0,05	-
* For passengers transport on the Mediterranean Corridor for less than 80 km, the amount for C1 lines services will be applied.	Off-peak	A1	0,75	0,70	-	0,84
		A2	0,70	0,65	-	0,75
		B1*	-	0,10	0,05	0,06
		C1	-	0,10	0,05	-

Operating tariff

(euros/train-km run)	Line type	Type of service			
		V1	V2	M	P
Class C	A1	2,00	0,75	-	-
	A2	1,90	0,70	-	-
	B1	0,60	0,06	0,06	-
	C1	-	0,06	0,06	-

Traffic tariff

(euros/100 seats-km)	Line type	Time period		
		Peak	Normal	Off-peak
Class D	A1	1,25	0,70	-
	A2	1,20	0,65	-
	B1	-	-	-
	C1	-	-	-

Tariffs for track access to services facilities and supply of services

Tariff for station use

(euros/passenger)	Class	Distance			
		A	B	C	D
Class A	1st	0,77	0,43	0,20	0,08
	2nd	0,48	0,30	0,15	0,06
	3rd	0,04	0,04	0,04	0,02

Tariff for stabling and use of platforms at stations

(euros/train)	Class	Stabling		
		A	B	C
Class B	1st	2,00	3,00	4,00
	2nd	1,00	1,50	2,00
	3rd	-	-	-

Tariff for passing track gauge changer

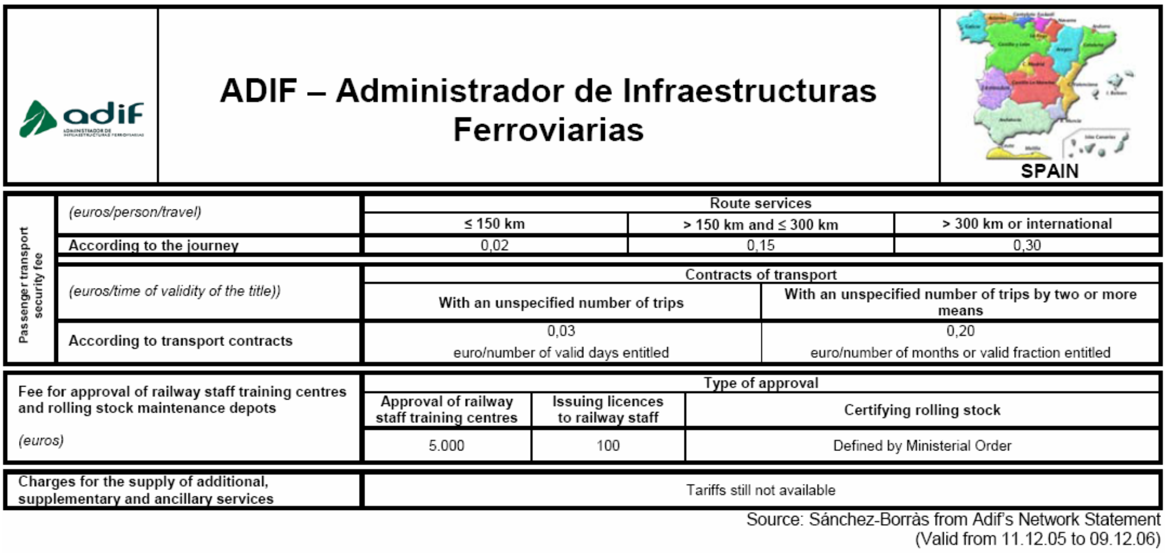
(euros/train)	
Class C	100 € (unit value per train)

Tariff for use of sidings

(euros/train)	Line type	Stabling			
		a	b	c	d
Class D	A	14,45	1,90	2,80	36,00
	B – C	-	-	-	-

Tariff for provision of services requiring permission for use of public railway property

(euros/m^2-month)	Public property area	
	Build on area	Non-build on area
Class E	0,6	0,5



adif
ADMINISTRADOR DE INFRAESTRUCTURAS FERROVIARIAS

ADIF – Administrador de Infraestructuras Ferroviarias

SPAIN

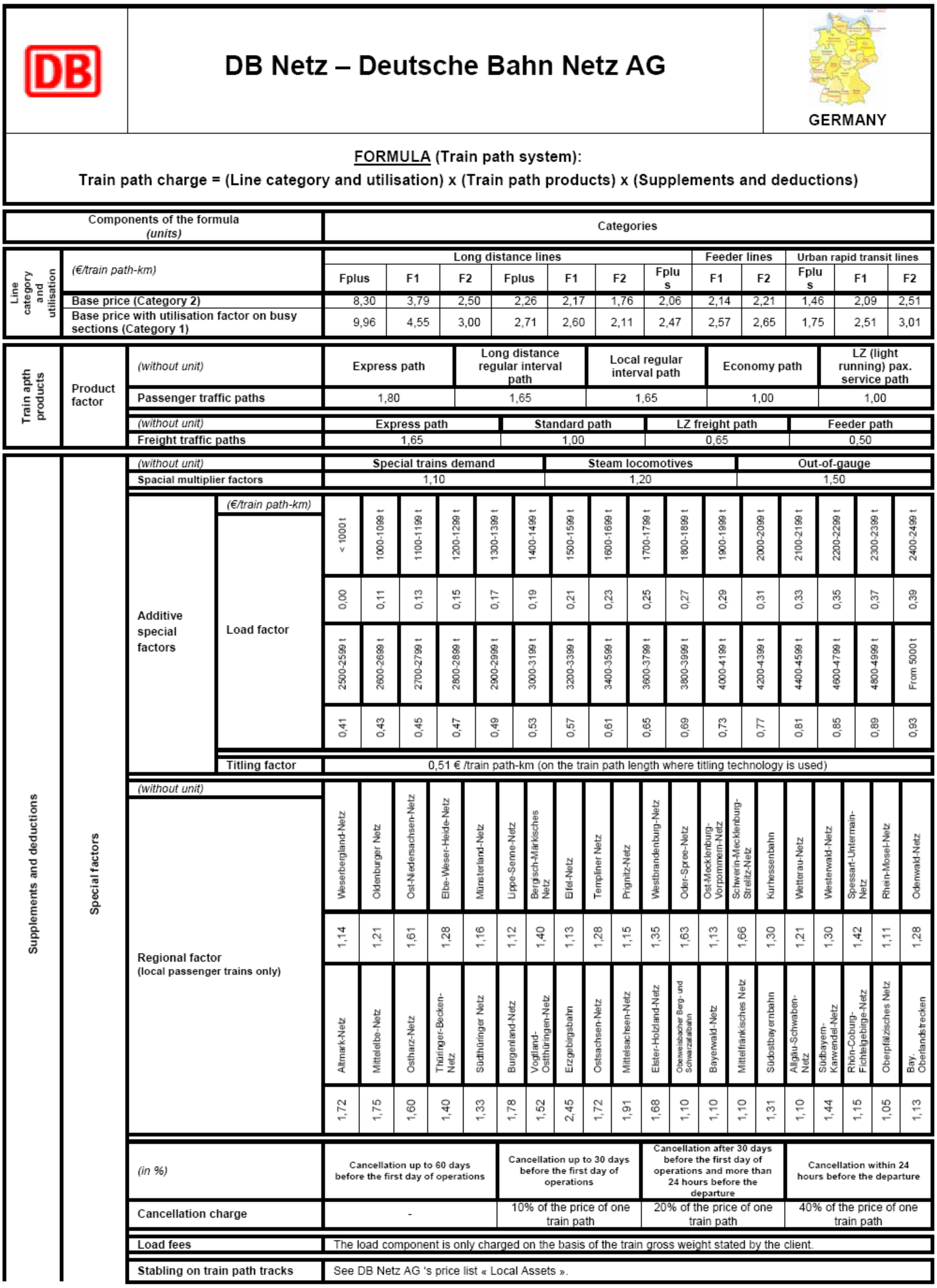
Passenger transport security fee	(euros/person/travel)	Route services		
		≤ 150 km	> 150 km and ≤ 300 km	> 300 km or international
	According to the journey	0,02	0,15	0,30

Passenger transport security fee	(euros/time of validity of the title))	Contracts of transport	
		With an unspecified number of trips	With an unspecified number of trips by two or more means
	According to transport contracts	0,03 euro/number of valid days entitled	0,20 euro/number of months or valid fraction entitled

Fee for approval of railway staff training centres and rolling stock maintenance depots	Type of approval		
	Approval of railway staff training centres	Issuing licences to railway staff	Certifying rolling stock
(euros)	5.000	100	Defined by Ministerial Order

Charges for the supply of additional, supplementary and ancillary services	Tariffs still not available

Source: Sánchez-Borràs from Adif's Network Statement
(Valid from 11.12.05 to 09.12.06)



DB Netz – Deutsche Bahn Netz AG

GERMANY

FORMULA (Train path system):

Train path charge = (Line category and utilisation) x (Train path products) x (Supplements and deductions)

Components of the formula (units)	Categories

		Long distance lines							Feeder lines		Urban rapid transit lines		
Line category and utilisation	(€/train path-km)	Fplus	F1	F2	Fplus	F1	F2	Fplus	F1	F2	Fplus	F1	F2
	Base price (Category 2)	8,30	3,79	2,50	2,26	2,17	1,76	2,06	2,14	2,21	1,46	2,09	2,51
	Base price with utilisation factor on busy sections (Category 1)	9,96	4,55	3,00	2,71	2,60	2,11	2,47	2,57	2,65	1,75	2,51	3,01

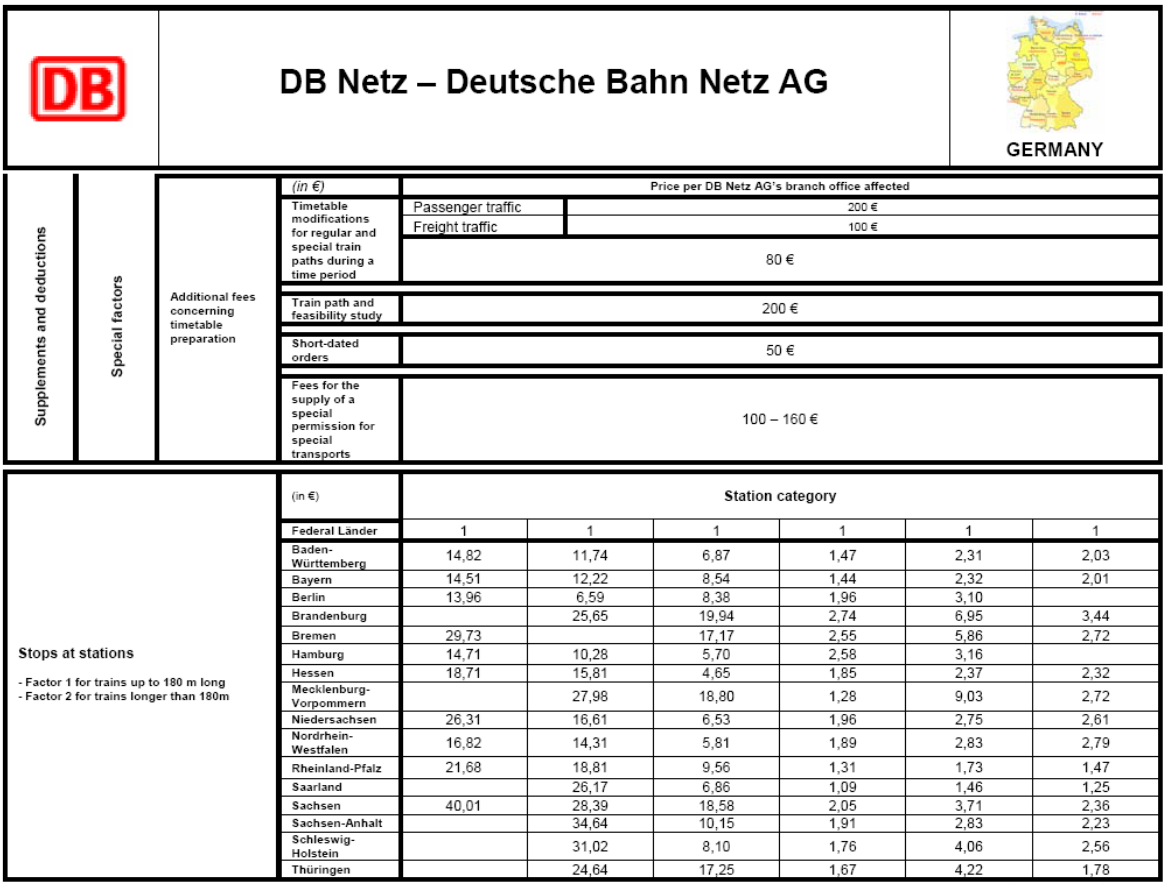
Train apth products	Product factor	(without unit)	Express path	Long distance regular interval path	Local regular interval path	Economy path	LZ (light running) pax. service path
		Passenger traffic paths	1,80	1,65	1,65	1,00	1,00
		(without unit)	Express path	Standard path	LZ freight path	Feeder path	
		Freight traffic paths	1,65	1,00	0,65	0,50	

Supplements and deductions	Special factors	(without unit)	Special trains demand	Steam locomotives	Out-of-gauge
		Spacial multiplier factors	1,10	1,20	1,50

		(€/train path-km)																
Additive special factors	Load factor		< 1000 t	1000-1099 t	1100-1199 t	1200-1299 t	1300-1399 t	1400-1499 t	1500-1599 t	1600-1699 t	1700-1799 t	1800-1899 t	1900-1999 t	2000-2099 t	2100-2199 t	2200-2299 t	2300-2399 t	2400-2499 t
			0,00	0,11	0,13	0,15	0,17	0,19	0,21	0,23	0,25	0,27	0,29	0,31	0,33	0,35	0,37	0,39
			2500-2599 t	2600-2699 t	2700-2799 t	2800-2899 t	2900-2999 t	3000-3199 t	3200-3399 t	3400-3599 t	3600-3799 t	3800-3999 t	4000-4199 t	4200-4399 t	4400-4599 t	4600-4799 t	4800-4999 t	From 5000 t
			0,41	0,43	0,45	0,47	0,49	0,53	0,57	0,61	0,65	0,69	0,73	0,77	0,81	0,85	0,89	0,93
	Titling factor		0,51 € /train path-km (on the train path length where titling technology is used)															

(without unit)																						
Regional factor (local passenger trains only)	Weserbergland-Netz	Oldenburger Netz	Ost-Niedersachsen-Netz	Elbe-Weser-Heide-Netz	Münsterland-Netz	Lippe-Senne-Netz	Bergisch-Märkisches Netz	Eifel-Netz	Templiner Netz	Prignitz-Netz	Westbrandenburg-Netz	Oder-Spree-Netz	Ost-Mecklenburg-Vorpommern-Netz	Schwerin-Mecklenburg-Strelitz-Netz	Kurhessenbahn	Wetterau-Netz	Westerwald-Netz	Spessart-Untermain-Netz	Rhein-Mosel-Netz	Odenwald-Netz		
	1,14	1,21	1,61	1,28	1,16	1,12	1,40	1,13	1,28	1,15	1,35	1,63	1,13	1,66	1,30	1,21	1,30	1,42	1,11	1,28		
	Altmark-Netz	Mittelelbe-Netz	Ostharz-Netz	Thüringer-Becken-Netz	Südthüringer Netz	Burgenland-Netz	Vogtland-Ostthüringen-Netz	Erzgebirgsbahn	Ostsachsen-Netz	Mittelsachsen-Netz	Elster-Holzland-Netz	Oberweisbacher Berg- und Schwarzatalbahn	Bayerwald-Netz	Mittelfränkisches Netz	Südostbayernbahn	Allgäu-Schwaben-Netz	Südbayern-Karwendel-Netz	Rhön-Coburg-Fichtelgebirge-Netz	Oberpfälzisches Netz	Bay. Oberlandstrecken		
	1,72	1,75	1,60	1,40	1,33	1,78	1,52	2,45	1,72	1,91	1,68	1,10	1,10	1,10	1,31	1,10	1,44	1,15	1,05	1,13		

(in %)	Cancellation up to 60 days before the first day of operations	Cancellation up to 30 days before the first day of operations	Cancellation after 30 days before the first day of operations and more than 24 hours before the departure	Cancellation within 24 hours before the departure
Cancellation charge	-	10% of the price of one train path	20% of the price of one train path	40% of the price of one train path
Load fees	The load component is only charged on the basis of the train gross weight stated by the client.			
Stabling on train path tracks	See DB Netz AG 's price list « Local Assets ».			



DB Netz – Deutsche Bahn Netz AG

GERMANY

Supplements and deductions	Special factors	Additional fees concerning timetable preparation	(in €)	Price per DB Netz AG's branch office affected	
			Timetable modifications for regular and special train paths during a time period	Passenger traffic	200 €
				Freight traffic	100 €
				80 €	
			Train path and feasibility study	200 €	
			Short-dated orders	50 €	
			Fees for the supply of a special permission for special transports	100 – 160 €	

	(in €)	Station category					
Stops at stations - Factor 1 for trains up to 180 m long - Factor 2 for trains longer than 180m	Federal Länder	1	1	1	1	1	1
	Baden-Württemberg	14,82	11,74	6,87	1,47	2,31	2,03
	Bayern	14,51	12,22	8,54	1,44	2,32	2,01
	Berlin	13,96	6,59	8,38	1,96	3,10	
	Brandenburg		25,65	19,94	2,74	6,95	3,44
	Bremen	29,73		17,17	2,55	5,86	2,72
	Hamburg	14,71	10,28	5,70	2,58	3,16	
	Hessen	18,71	15,81	4,65	1,85	2,37	2,32
	Mecklenburg-Vorpommern		27,98	18,80	1,28	9,03	2,72
	Niedersachsen	26,31	16,61	6,53	1,96	2,75	2,61
	Nordrhein-Westfalen	16,82	14,31	5,81	1,89	2,83	2,79
	Rheinland-Pfalz	21,68	18,81	9,56	1,31	1,73	1,47
	Saarland		26,17	6,86	1,09	1,46	1,25
	Sachsen	40,01	28,39	18,58	2,05	3,71	2,36
	Sachsen-Anhalt		34,64	10,15	1,91	2,83	2,23
	Schleswig-Holstein		31,02	8,10	1,76	4,06	2,56
	Thüringen		24,64	17,25	1,67	4,22	1,78

Source: Sánchez-Borràs from:
1) Network Statement (Products Train Paths. Modular Train Path Price System, 02/2005), valid from 11.12.2005 to 10.12.06.
2) Stationspreisliste 2006 (valid from 01.01.06)
3) Bahnhofskategorisierung der DB Station+Service AG

RFI – Rete Ferroviaria Italiana SpA

ITALY

FORMULA :

Charge = (Basic access package) + (Mandatory services) + (Complementary services) + (Ancillary services) +
+ (Charge for clearing the infrastructure by means of locomotives of trains belonging to a railway undertaking unconnected to the cause of the obstruction) +
+ (Unit value of average trains*km for calculating the performance bond under the framework) + (Penalties)

Components of the formula *(units)*	Categories

Basic access package

Basic access package = Access charge – Discount

Access charge

Access charge = Charge $_{section/node}$ + Charge $_{km/minutes}$ + Charge $_{power\ consumption}$

Charge $_{section/node}$ (*) (Unit cost of access)

$$Charge_{section/node} = \sum_{j=1}^{n} val_j^F + \max(val_l^C) + \sum_{r=1}^{t} val_r^N \quad \text{with} \quad k = 1,2, \dots q$$

Access to the sections of the trunk line net — *(€ / section)* — val^F_j

Code of section (j)

1	2	3	4	5	6	7	8	9	10
54,23	54,23	54,23	54,23	54,23	54,23	54,23	54,23	49,06	49,06
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
54,23	54,23	54,23	54,23	49,06	49,06	54,23	54,23	54,23	54,23
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
54,23	54,23	54,23	54,23	54,23	54,23	54,23	54,23	49,06	49,06
31	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
54,23	54,23	54,23	54,23	54,23	54,23	54,23	54,23	54,23	54,23
41	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**
56,81	56,81	56,81	56,81	54,23	54,23	49,06	49,06	54,23	54,23
51	**52**	**53**	**54**	**55**	**56**	**57**	**58**	**59**	**60**
54,23	54,23	54,23	54,23	64,56	64,56	56,81	56,81	54,23	54,23
61	**62**	**63**	**64**	**65**	**66**	**67**	**68**	**69**	**70**
54,23	54,23	54,23	54,23	49,06	49,06	54,23	54,23	54,23	54,23

71	72	73	74	75	76	77	78
49,06	49,06	54,23	54,23	56,81	56,81	56,81	56,81

Access to the lines of the complementary network — *(€ / section)* — val^C_k

Line code (k)

Secondary line	Secondary line	Secondary line						
1, 2, ..,191	192,193..233	234	235	236	237	238	239	240
46,48	0,00	23,24	23,24	23,24	23,24	23,24	23,24	27,11

Shuttle lines (suite)

241	242	243	244	245	246	247	248
23,24	23,24	23,24	23,24	23,24	23,24	23,24	23,24

Access to the nodes

(€ / node)	Code of node (r) (Node)							
	1 Torino	2 Milano	3 Venezia	4 Genova	5 Bologna	6 Firenze	7 Roma	8 Napoli
val^N_r	51,65	51,65	51,65	51,65	51,65	51,65	51,65	51,65

Charge $_{km/min}$ (*)

Charge $_{km/min}$ = Charge $_{km/min}$ (Main Network) + Charge $_{km/min}$ (Complementary Network) + Charge $_{km/min}$ (Node)

Runs on lines of the trunk line net

$$\text{Charge}_{km/min}(P.N.) = Pbasekm^R \times \sum_{j=1}^{n}\sum_{w=1}^{s} km^F_{jw} \times (\alpha_1 \times P_{speed} + \alpha_2 \times P_{density} + \alpha_3 \times P_{usage})$$

with $\alpha_1 + \alpha_2 + \alpha_3 = 1$ and $\alpha_1 = 1/3$, $\alpha_2 = 1/3$, $\alpha_3 = 1/3$

(€ / km) Pbasekm^F	1

P_{speed}

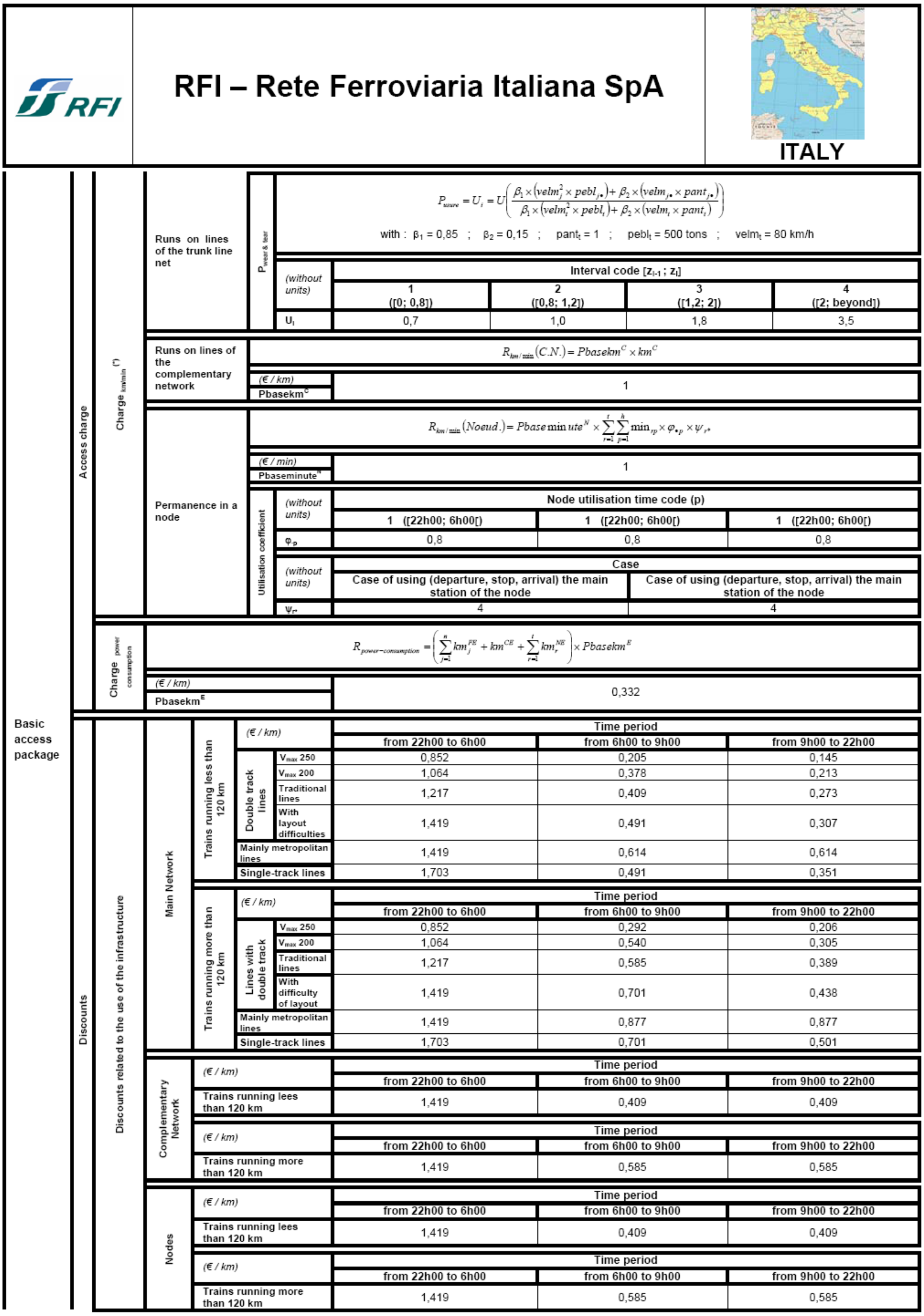
$$P_{speed} = V_i = V\left(\frac{|vel_{jw} - velomo_{jw}|}{velomo_{jw}}\right) \quad \text{with} \quad m_{i-1} \le \frac{|vel_{jw} - velomo_{jw}|}{velomo_{jw}} < m_i$$

(without units)	Interval code $[m_{i-1} ; m_i]$			
	1 ([0; 0,2])	2 ([0,2; 0,5])	3 ([0,5; 1])	4 ([1; beyond])
V_i	1,0	1,3	3,0	5,0

$P_{density}$

$$P_{density} = D_i = D(dens_{jw})$$

(without units)	Interval code $[v_{i-1} ; v_i]$		
	1 ([0; 0,5])	2 ([0,5; 0,75])	3 ([0,75; beyond])
D_i	0,3	1,0	1,5



RFI – Rete Ferroviaria Italiana SpA

ITALY

Basic access package

Access charge

Charge km/min (*)

Runs on lines of the trunk line net – $P_{wear \& tear}$

$$P_{usure} = U_i = U\left(\frac{\beta_1 \times (velm_j^2 \times pebl_{j\bullet}) + \beta_2 \times (velm_{j\bullet} \times pant_{j\bullet})}{\beta_1 \times (velm_t^2 \times pebl_t) + \beta_2 \times (velm_t \times pant_t)}\right)$$

with : $\beta_1 = 0{,}85$; $\beta_2 = 0{,}15$; $pant_t = 1$; $pebl_t = 500$ tons ; $velm_t = 80$ km/h

(without units)	Interval code $[z_{I-1} ; z_I]$			
	1 ([0; 0,8])	2 ([0,8; 1,2])	3 ([1,2; 2])	4 ([2; beyond])
U_I	0,7	1,0	1,8	3,5

Runs on lines of the complementary network

$$R_{km/min}(C.N.) = Pbasekm^C \times km^C$$

(€ / km) Pbasekm^C	1

Permanence in a node

$$R_{km/min}(Noeud.) = Pbase\min ute^N \times \sum_{r=1}^{t}\sum_{p=1}^{h} \min_{rp} \times \varphi_{\bullet p} \times \psi_{r\bullet}$$

(€ / min) Pbaseminute^N	1

Utilisation coefficient

(without units)	Node utilisation time code (p)		
	1 ([22h00; 6h00[)	1 ([22h00; 6h00[)	1 ([22h00; 6h00[)
$\varphi_{\cdot p}$	0,8	0,8	0,8

(without units)	Case	
	Case of using (departure, stop, arrival) the main station of the node	Case of using (departure, stop, arrival) the main station of the node
$\psi_{r\cdot}$	4	4

Charge power consumption

$$R_{power-consumption} = \left(\sum_{j=1}^{n} km_j^{FE} + km^{CE} + \sum_{r=1}^{t} km_r^{NE}\right) \times Pbasekm^E$$

(€ / km) Pbasekm^E	0,332

Discounts

Discounts related to the use of the infrastructure

Main Network

Trains running less than 120 km

(€ / km)		Time period		
		from 22h00 to 6h00	from 6h00 to 9h00	from 9h00 to 22h00
Double track lines	V_{max} 250	0,852	0,205	0,145
	V_{max} 200	1,064	0,378	0,213
	Traditional lines	1,217	0,409	0,273
	With layout difficulties	1,419	0,491	0,307
Mainly metropolitan lines		1,419	0,614	0,614
Single-track lines		1,703	0,491	0,351

Trains running more than 120 km

(€ / km)		Time period		
		from 22h00 to 6h00	from 6h00 to 9h00	from 9h00 to 22h00
Lines with double track	V_{max} 250	0,852	0,292	0,206
	V_{max} 200	1,064	0,540	0,305
	Traditional lines	1,217	0,585	0,389
	With difficulty of layout	1,419	0,701	0,438
Mainly metropolitan lines		1,419	0,877	0,877
Single-track lines		1,703	0,701	0,501

Complementary Network

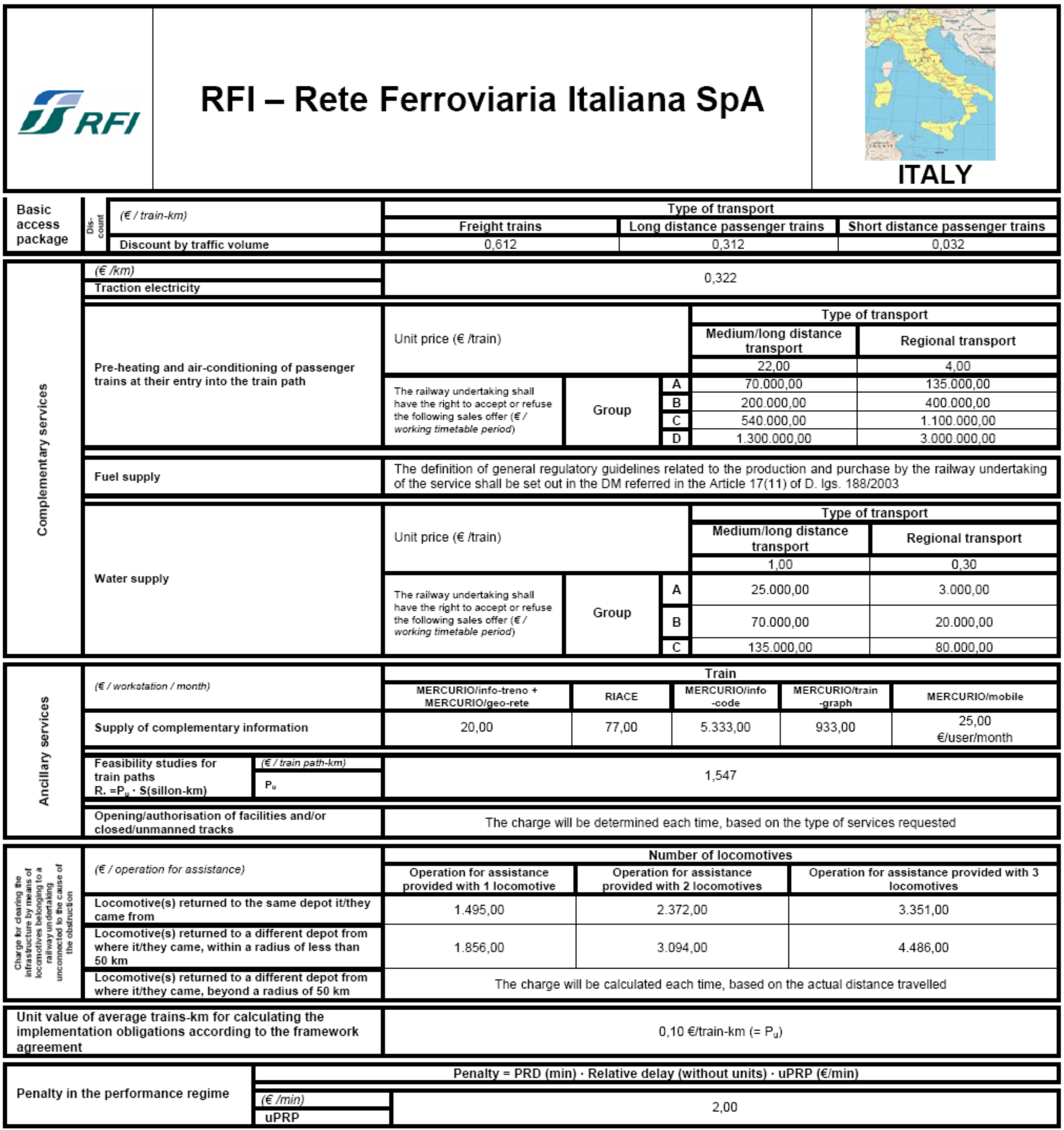
(€ / km)	Time period		
	from 22h00 to 6h00	from 6h00 to 9h00	from 9h00 to 22h00
Trains running lees than 120 km	1,419	0,409	0,409

(€ / km)	Time period		
	from 22h00 to 6h00	from 6h00 to 9h00	from 9h00 to 22h00
Trains running more than 120 km	1,419	0,585	0,585

Nodes

(€ / km)	Time period		
	from 22h00 to 6h00	from 6h00 to 9h00	from 9h00 to 22h00
Trains running lees than 120 km	1,419	0,409	0,409

(€ / km)	Time period		
	from 22h00 to 6h00	from 6h00 to 9h00	from 9h00 to 22h00
Trains running more than 120 km	1,419	0,585	0,585



RFI – Rete Ferroviaria Italiana SpA

ITALY

			Type of transport		
Basic access package	Dis-count	(€ / train-km)	Freight trains	Long distance passenger trains	Short distance passenger trains
		Discount by traffic volume	0,612	0,312	0,032

Complementary services	(€ /km) Traction electricity	0,322				
	Pre-heating and air-conditioning of passenger trains at their entry into the train path	Unit price (€ /train)			Type of transport	
					Medium/long distance transport	Regional transport
					22,00	4,00
		The railway undertaking shall have the right to accept or refuse the following sales offer (€ / *working timetable period*)	Group	A	70.000,00	135.000,00
				B	200.000,00	400.000,00
				C	540.000,00	1.100.000,00
				D	1.300.000,00	3.000.000,00
	Fuel supply	The definition of general regulatory guidelines related to the production and purchase by the railway undertaking of the service shall be set out in the DM referred in the Article 17(11) of D. lgs. 188/2003				
	Water supply	Unit price (€ /train)			Type of transport	
					Medium/long distance transport	Regional transport
					1,00	0,30
		The railway undertaking shall have the right to accept or refuse the following sales offer (€ / *working timetable period*)	Group	A	25.000,00	3.000,00
				B	70.000,00	20.000,00
				C	135.000,00	80.000,00

Ancillary services	*(€ / workstation / month)*		Train				
			MERCURIO/info-treno + MERCURIO/geo-rete	RIACE	MERCURIO/info-code	MERCURIO/train-graph	MERCURIO/mobile
	Supply of complementary information		20,00	77,00	5.333,00	933,00	25,00 €/user/month
	Feasibility studies for train paths R. =P_u · S(sillon-km)	*(€ / train path-km)* P_u	1,547				
	Opening/authorisation of facilities and/or closed/unmanned tracks		The charge will be determined each time, based on the type of services requested				

Charge for clearing the infrastructure by means of locomotives belonging to a railway undertaking unconnected to the cause of the obstruction	*(€ / operation for assistance)*	Number of locomotives		
		Operation for assistance provided with 1 locomotive	Operation for assistance provided with 2 locomotives	Operation for assistance provided with 3 locomotives
	Locomotive(s) returned to the same depot it/they came from	1.495,00	2.372,00	3.351,00
	Locomotive(s) returned to a different depot from where it/they came, within a radius of less than 50 km	1.856,00	3.094,00	4.486,00
	Locomotive(s) returned to a different depot from where it/they came, beyond a radius of 50 km	The charge will be calculated each time, based on the actual distance travelled		

Unit value of average trains-km for calculating the implementation obligations according to the framework agreement	0,10 €/train-km (= P_u)

Penalty in the performance regime	Penalty = PRD (min) · Relative delay (without units) · uPRP (€/min)	
	(€ /min) uPRP	2,00

Source: Sánchez-Borràs from RFI's Network Statement (valid from 12.12.04 to 12.09.06) and Decree of March 21, 2000; Decree of March 22, 2000; Decree of April 11, 2003; Decree of July 15, 2003; Decree of March 24, 2005

(*) All the amounts relating to the charge by section/node and kilometre/minute, fixed by ministerial Decree of March 31, 2000, must be raised by:

+ 1,4% to take account of the inflation rate programmed for the year 2003 (Decree of July 15, 2003)

plus:

+ 1,7% to take account of the inflation rate programmed for the year 2004 (Decree of the March 24, 2005)

Infrabel

BELGIUM

FORMULA :

Charge for the use of the infrastructure = (Charge train path – line) + (Charge train path – installations) + + (Shunting charge) + (Administrative fees for the capacity requests treatment)

Components of the formula *(units)*	Categories

Charge train path – line for having access to and using the infrastructure

R = P x Ce x Pt x C x Σ [L(i) x C1(i) x C2(i) x H(i) x T(i)]

(€ value in 01.01.05) P	0,285073
(without units) Ce	1

(without units)	Category					
	1	2	3	4	5	6
Pt	**1,50**	**1,50**	**1,40**	**1,20**	**1,00**	**1,00**

(without units)	Category				
	1	2	3	4	5
C	1,20	1,55	1,90	2,25	2,60
	Remark: Increase of 0,35 for each additional 400 tonnes				

(without units)	Category				
	1	2	3	4	9
C1(i)	2	1,75	1,25	1	Not applicable

(without units)	Category						
	1	2	3	4	5	6	9
C2(i)	3,5	2,5	1,5	1,25	1	0,75	Not applicable

(without units)	Category H		
	1	2	3
H(i)	4	3	1

	(without units)	Difference compared to the standard train path			
		From 0,00% to 100%	From 100,01% to 200%	Form 200,01% to 300%	From .... % to .... %
T(i)	**Freight trains**	1,00	1,20	1,40	+ 0,2
	(without units)	Difference compared to the standard train path			
		From 0,00% to 5%	From 5,01% to 10%	From 10,01% to 15%	From .... % to .... %
	Passenger trains	1,00	1,15	1,30	+ 0,15

Charge train path – facility for having access to and using platforms

Passenger trains : $TR-I = Pv \times Cu \times C(i) + Pv \times \frac{C(i)}{5} \times time^{\left(1+\frac{C(i)}{100}\right)}$

Freight trains : $TR-I = Pm \times Cu \times C(i) + Pm \times \frac{C(i)}{100} \times time^{\left(1+\frac{C(i)}{10}\right)}$

(€ value in 01.01.05) Pv	1,800460
(€ value in 01.01.05) Pm	2,250566

(without units)	Type of stop			
	Origin facility	Destination facility	Intermediate commercial stop	Stop of service requested
Cu	4,0	3,5	3,0	3,0

	(without units)	Category of station				
		Terminal TGV Bruxelles-Midi train path TGV	1	2	3	9
C(i)	**Value C HKV passengers traffic**	20,0	10,0	2,5	1	Not applicable
	Value C HKM freight traffic	Not applicable	2	1	0	Not applicable

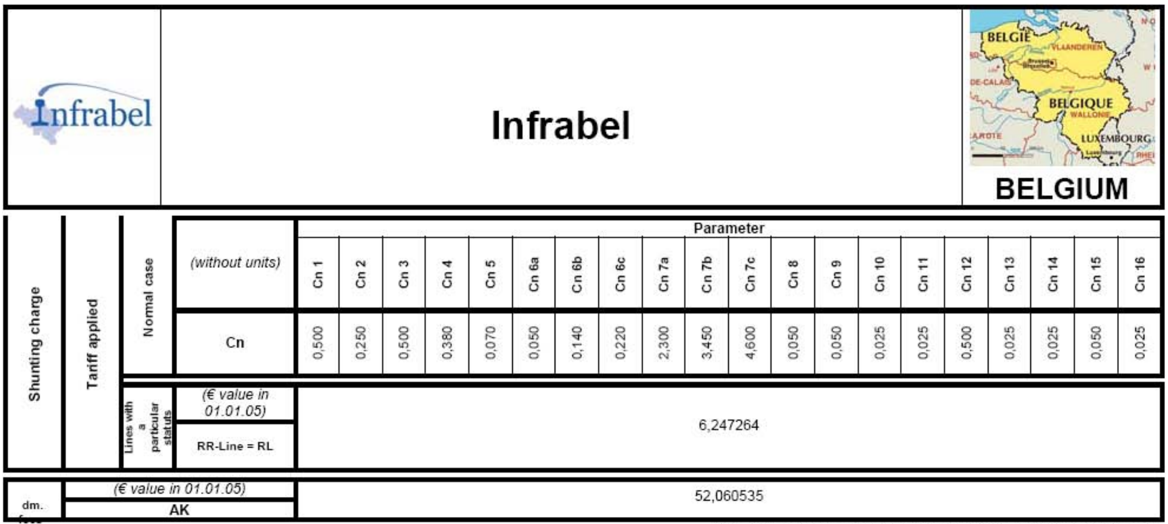
Shunting charge

Tariff applied

Normal case

1 year (1^{st} year) (100%)	1 day	3 hours	2^{nd} year	3^{rd} year	4^{th} year	5^{th} year	Form 6^{th} year on
RR = M x [Co x RB x (1 + ΣCn) + C(IB)]	$\frac{(1year)}{250}$	$\frac{(1day)}{8}$	99%	98%	97%	96%	95%

(€ value in 01.01.05) M	1,204681
(without units) Co	1,00 (for all the beams)
(without units) RB	
(without units) C(IB)	12,00



Infrabel

Infrabel

BELGIUM

				Parameter																			
Shunting charge	**Tariff applied**	**Normal case**	*(without units)*	Cn 1	Cn 2	Cn 3	Cn 4	Cn 5	Cn 6a	Cn 6b	Cn 6c	Cn 7a	Cn 7b	Cn 7c	Cn 8	Cn 9	Cn 10	Cn 11	Cn 12	Cn 13	Cn 14	Cn 15	Cn 16
			Cn	0,500	0,250	0,500	0,380	0,070	0,050	0,140	0,220	2,300	3,450	4,600	0,050	0,050	0,025	0,025	0,500	0,025	0,025	0,050	0,025
		Lines with a particular statuts	*(€ value in 01.01.05)*	6,247264																			
			RR-Line = RL																				

dm.	*(€ value in 01.01.05)*	52,060535
	AK	

Source: Sánchez-Borràs from Infrabel's Network Statement
(Valid from 11.12.05 to 09.12.06)

Network Rail

UNITED KINGDOM

FORMULA :

Track charges in relevant year t: $T_t = (F_t - (RIE_t + AGP_t)) + V_t + E_t + K_t + R_t + L_t - W_t$

Components of the formula (units)				Categories
Fixed charges	Fixed Track Access Charges [1]	F_t (£ in Relevant Year 2005/06)	(In 2004/05 prices)	Train operator

Train operator	F_t (In 2004/05 prices)
Anglia Railways Tain Sevices Ltd	14.152.278
Arriva Trains Northern Ltd / Arriva Trains Wales Ltd / Trenau Arriva	42.883.722
Cymru Ltd	26.812.717
C2C Rail Ltd	10.578.203
Central Trains Ltd	46.406.082
The Chiltern Railway Company Ltd	8.086.678
Cross Country Trains Ltd	68.936.653
Gatwick Express Ltd	4.991.155
Great Eastern Railway Ltd	23.478.045
Great North Eastern Railway Ltd	58.535.531
Great Western Trains Company Ltd	56.468.385
Merseyrail Electrics 2002 Ltd	8.868.532
Midland Mainline Ltd	16.596.694
North Western Trains Company Ltd	36.197.747
ScotRail Railways Ltd	60.598.239
Silverlink Train Services Ltd	32.667.418
South Central Ltd	41.896.867
South Eastern Trains Ltd	54.833.197
South West Trains Ltd	58.838.511
Thames Trains Ltd	15.108.697
Thameslink Rail Ltd	15.233.588
Wales and West Passenger Trains Ltd	9.677.344
West Anglia Great Northern Railway Ltd	36.568.412
West coast Trains Ltd	154.320.802

(In 2005/06 prices)

F_t = F_t (in 2004/05 prices) · $FTCI_t$ with $FTCI_t = 1 + \left(\frac{RPI_{t-1} - RPI_{2003}}{RPI_{2003}}\right)$

	Retail Prices Index	
(%)	RPI_{2005}	RPI_{2003}
$FTCI_t$		

RAB Increase Equivalent (RIE_t)

$RIE_t = RI_t \cdot \frac{F_t}{AF_t} \cdot FTCI_t$ with $FTCI_t = 1 + \left(\frac{RPI_{t-1} - RPI_{2003}}{RPI_{2003}}\right)$

(million £ in Relevant Year 2005/06)	Circumstances	
	If first issuance and/or drawdown under the Debt Issuance Program has occurred on or before 31 December 2004	If first issuance and/or drawdown under the Debt Issuance Program has NOT occurred on or before 31 December 2004
RI_t	1.701	0
AF_t		

Additional Grant Proportion (AGP_t)

$AGP_t = AG_t \cdot \frac{F_t}{AF_t} \cdot FTCI_t$

(£ in Relevant Year 2005/06))	Circumstances	
	If first issuance and/or drawdown under the Debt Issuance Program has occurred on or before 31 December 2004	If first issuance and/or drawdown under the Debt Issuance Program has NOT occurred on or before 31 December 2004
AG_t	986,81 million	2.688,02 million

Variable charges – Variable Track Usage Charge (V_t)

$Vt = \sum V_{it} \cdot UV_{it}$ with UV_{it} = actual volume of usage (in vehicle miles) in Relevant Year of vehicle type *i* operated by or on behalf of the train operator

Vehicle type: Loco	V_{it} (pence per vehicle mile in Relevant Year 2004-05) (in 2004/05 prices)
008/0	2,82
031/1	48,65
031/4	48,65
033/2	36,51
037/0	39,50
037/3	39,50
037/4	39,50
037/5	39,50
037/6	39,50
037/7	39,50
043/0	39,61
047/0	69,35
047/2	69,35
047/3	69,35
047/4	69,35
047/7	69,35
047/9	69,35
050/0	56,79
067 (passenger use)	96,74
073/0	48,66
073/1	48,66
073/2	48,66
086/1	56,44
086/2	56,44

Network Rail

UNITED KINGDOM

Variable charges

Variable Track Usage Charge (V_t)

V_{it}

Loco							Coach							Dies MU									
086/4	086/6	087/0	089/0	090/0	090/1	091/0	0	1	2	3	4	D	Y	101 Motor Car	101 Trailer Car	117 Motor Car	117 Trailer Car	121 Motor Car	141 motor Car	142 Motor Car	143 Motor Car	144 Motor car	150 Motor Car
56,44	56,44	59,80	68,10	64,76	64,76	63,75	10,96	11,83	10,74	11,25	19,34	10,74	11,25	6,56	4,42	8,60	6,10	8,60	8,90	8,90	8,85	8,84	8,64

Dies MU																			Elec MU				
153 Motor Car	155 Motor Car	156 Motor Car	158 Motor Car	159 Motor car	165 Motor Car	166 Motor Car	168 Motor Car	170 Motor Car	175 Motor Car	180 Motor Car	201 Motor Car	201 Trailer Car	205 Motor Car	205 Trailer Car	207 Motor Car	207 Trailerr Car	220 Motor Car	221 Motor Car	303 Motor Car	303 Trailer Car	305 Motor Car	305 Trailer Car	308 Motor Car
9,28	9,17	9,67	11,26	11,11	11,38	12,14	12,65	14,19	19,49	24,52	19,04	6,90	16,46	6,49	15,64	5,73	20,61	27,52	15,42	7,11	18,83	7,75	17,66

Elec MU																							
308 Trailer Car	309 Motor Car	309 Trailer Car	310 Motor Car	310 Trailer Car	312 Motor Car	312 Trailer Car	313 Motor Car	313 Trailer Car	314 Motor Car	314 Trailer Car	315 Motor Car	315 Trailer Car	317 Motor Car	317 Trailer Car	318 Motor Car	318 Trailer Car	319 Motor Car	319 Trailer Car	320 Motor Car	320 Trailer Car	321 Motor Car	321 Trailer Car	322 Motor Car
7,29	22,76	10,33	19,44	7,87	18,02	7,91	6,24	4,85	6,85	6,05	8,70	5,73	16,00	6,49	17,98	7,10	18,42	7,35	13,78	5,19	20,74	7,69	20,74

Elec MU																							
322 Trailer Car	323 Motor Car	323 Trailer Car	333 Motor Car	333 Trailer Car	334 Motor Car	334 Trailer Car	357 Motor Car	357 Trailer Car	365 Motor Car	365 Trailer Car	373/L	373/C	411 Motor Car	411 Trailer Car	412 Motor Car	412 Trailer Car	421 Motor Car	421 Trailer Car	422 Motor Car	422 Trailer Car	423 Motor Car	423 Trailer Car	442 Motor Car
7,69	9,12	8,17	16,68	12,92	13,73	10,77	12,05	11,62	9,29	6,26	73,34	20,57	12,51	6,98	14,82	8,98	15,56	8,00	15,56	7,97	15,28	7,48	19,10

Elec MU																				De-icing		DVT	
442 Trailer Car	455 Motor Car	455 Trailer Car	456 Motor Car	456 Trailer Car	458 Motor Car	458 Trailer Car	460 Motor Car	460 Trailer Car	465 Motor Car	465 Trailer Car	466 Motor Car	466 Trailer Car	489 Motor Car	507 Motor Car	507 Trailer Car	508 Motor Car	508 Trailer Car	930 Motor Car	930 Trailer Car	936 Motor Car	936 Trailer Car	V (Virgin)	W (GNER)
9,85	11,33	4,93	8,81	4,92	11,04	7,26	13,90	9,52	7,62	4,62	7,60	4,65	11,78	7,75	4,30	8,16	4,53	20,31	5,87	16,44	7,42	15,95	18,46

Traction Electricity Charge (E_t)

$$E_t = \sum C_i \cdot E_{gjt} \cdot UE_{igjt} + \sum C_i \cdot EV_t \cdot UE_{igjt} \quad \text{with} \quad E_{gjt} = E_{gjt-1}\left[1+\frac{I_{t-1}}{100}\right] \quad \text{and} \quad EV_t = EV_{t-1}\left[1+\frac{RPI_{t-1}-0}{100}\right]$$

and UE_{igjt} = actual volume of usage (in electrified train Miles in relation to the electric multiple units or Gross Tonne Miles in relation to locomotive hauled units) of trains operated by or on behalf of the Train Operator in train category i, in Geographic Area g, in tariff band j and in relevant year t

C_i	Shall be determined for individual services through reference to the calibrated consumption rates set out in the traction electricity consumption rates for franchised passenger services

(pence per kWh in Relevant year 2001/02) (in 2001/02 prices)	Period			Tariff zone								
				East Coast	Great Eastern	LTS	Merseyside	MidlandMain Line	Scotland	Southern	West Anglia	West Coast
$E_{gj2001/02}$	Winter	Weekday	0730-1559	4,963	4,875	5,462	4,941	4,711	3,842	4,696	4,697	4,891
			1600-1859	13,334	14,619	15,680	13,195	14,328	6,258	14,775	13,821	14,063
			1900-0729	3,714	3,592	4,208	3,694	3,418	3,842	3,436	3,406	3,631
		Weekend	0730-1859	3,557	3,463	4,056	3,513	3,301	3,842	3,298	3,281	3,479
			1900-0729	2,946	2,826	3,441	2,921	2,654	3,842	2,677	2,637	2,866
	Summer	Weekday	0730-1859	3,739	3,643	4,226	3,714	3,502	3,842	3,468	3,457	3,662
			1900-0729	2,988	2,854	3,511	2,915	2,694	3,842	2,681	2,639	2,822
		Weekend	0730-1859	2,715	2,621	3,206	2,661	2,465	3,842	2,463	2,430	2,634
			1900-0729	2,473	2,349	2,955	2,438	2,179	3,842	2,201	2,155	2,384

(Pence/kWh in 2001/02 prices) $EV_{2001/0}$	0,89

Network Rail

Network Rail

UNITED KINGDOM

Variable charges

Capacity Charge (K_t)

$$K_t = \left[\sum (Pg_t \cdot Tg_t)\right] - CC_t$$

with Tgt = actual train miles run by Services in Service Group g in the Relevant Year t and $CC_t = CC_{t-1}\left[1+\frac{RPI_{t-1}}{100}\right]$ and $Pg_t = Pg_{t-1}\left[1+\frac{RPI_{t-1}}{100}\right]$

(£/ train mile in Relevant Year 2004/05)

Pg_t

Train Operator Company

Scotrail								GNER					Arriva Trains Northern											
HA01	HA02	HA03	HA04	HA06	HA07	HA11	HA99	HB01	HB02	HB04	HB05	HB99	HC01	HC02	HC03	HC04	HC05	HC06	HC07	HC08	HC09	HC10	HC99
0,0671	0,1344	0,0256	0,0014	0,0822	0,1093	0,1656	0,1371	0,3523	0,4235	0,3523	0,3523	0,1562	0,1210	0,0443	0,0787	0,0831	0,0590	0,1451	0,0933	0,2149	0,1402	0,2109	0,1450

First North Western							Merseyrail		Virgin West Coast						Central Trains							Virgin Cross Country	
HD01	HD02	HD03	HD04	HD06	HD09	HD99	HE01	HE02	HF01	HF02	HF03	HF04	HF05	HF06	HG01	HG02	HG03	HG05	HG06	HG07	HG12	HH01	HH99
0,2343	0,1814	0,3635	0,0574	0,0721	0,0392	0,0922	0,0218	0,0003	1,4173	0,8787	0,7712	0,9824	0,9885	0,6915	0,1465	0,9319	0,3701	0,3973	0,4169	0,1735	0,1613	0,5424	0,3950

Midland Mainline		First Great Western				Wales and West					Cardiff Railways							Thames Trains					Chiltern
HI01	HI02	HJ01	HJ02	HJ03	HJ04	HK11	HK12	HK13	HK14	HK99	HL02	HL03	HL04	HL05	HL06	HL07	HL08	HN01	HN02	HN03	HN04	HN05	HO01
1,5999	1,5999	1,0225	1,0225	1,0225	1,0225	0,2677	0,2677	0,2677	0,2677	0,2677	0,2677	0,2677	0,2677	0,2677	0,2677	0,0110	0,1355	1,6462	2,1344	0,7916	0,3672	0,2791	0,0555

Chiltern		Silverlink				WAGN					First Great Eastern			Anglia		c2c		South Eastern Trains					Gatwick Express
HO02	HO03	HP01	HP03	HP04	HP06	HQ01	HQ03	HQ04	HQ05	HQ99	HR01	HR02	HR03	HS01	HS02	HT01	HT02	HU01	HU02	HU03	HU04	HU05	HV01
0,3252	0,2289	0,0179	1,1688	0,0001	0,2266	0,3765	0,4483	0,1011	0,2463	0,1290	0,5956	0,3756	0,6226	0,4565	0,0318	0,1662	0,1662	0,1845	0,3861	0,1693	0,9947	2,6349	1,1015

South Central						Thameslink			South West Trains							
HW01	HW02	HW03	HW04	HW05	HW06	HX01	HX02	HX03	HY01	HY02	HY03	HY04	HY05	HY06	HY07	HY08
0,0763	1,9938	0,5454	0,4347	1,3946	0,9464	1,8530	1,0110	0,2370	0,3338	0,1102	0,1322	0,2466	0,2503	0,1550	0,2399	0,1854

(£ in Relevant Year 2004/05)

(In 2004/05 prices)

$CC_{2004\text{-}05}$

Train operator	
Anglia Railways Train Services Ltd	1.208.621
Arriva Trains Northern Ltd	3.176.846
C2C Rail Ltd	687.384
Cardiff Railway Company Ltd	3.195.072
Central Trains Ltd	7.529.525
The Chiltern Railway Company Ltd	1.129.269
Cross Country Trains Ltd	6.329.668
Gatwick Express Ltd	1.763.704
Great Eastern Railway Ltd	4.484.551
Great North Eastern Railway Ltd	4.123.502
Great Western Trains Company Ltd	9.978.542
Merseyrail Electrics 2002 Ltd	46.320
Midland Mainline Ltd	9.768.720
North Western Trains Company Ltd	2.389.850
ScotRail Railways Ltd	1.833.956
Silverlink Train Services Ltd	5.492.025
South Central Ltd	9.978.944
South Eastern Trains Ltd	8.609.832
South West Trains Ltd	4.902.704
Thames Trains Ltd	10.714.919
Thameslink Rail Ltd	10.658.281
Wales and West Passenger Trains Ltd	1.752.794
West Anglia Great Northern Railway Ltd	3.561.640
West coast Trains Ltd	11.883.903

Network Rail

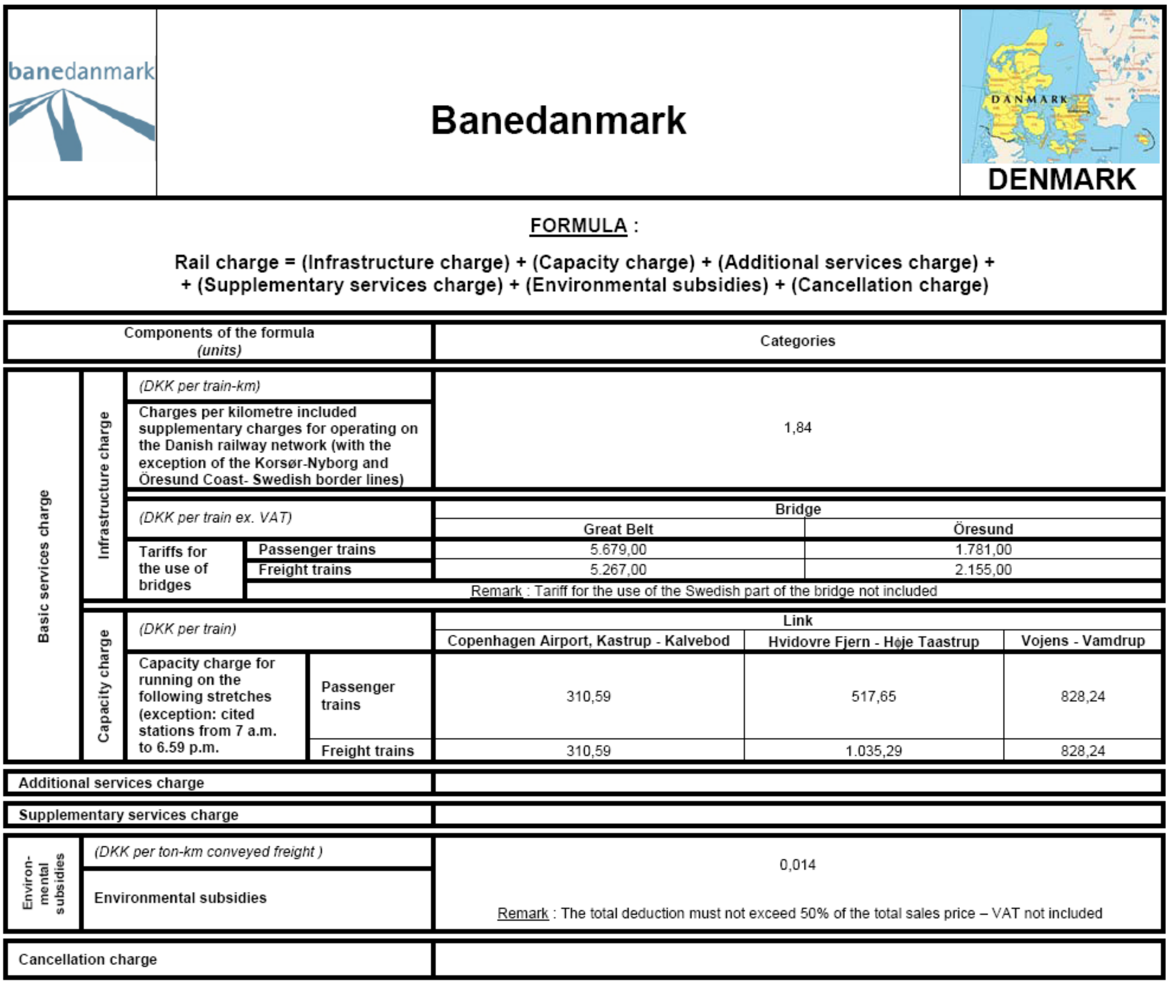
UNITED KINGDOM

Variable charges	Rail safety Charge (R_t)		Appropriate proportion of the determined amount of the aggregate Railway Safety Charge in respect of year t which shall be recovered from the Train Operator, such appropriate proportion to be calculated pro rata to the share attributed to the Train Operator of the aggregate total Fixed Track Charge for Relevant Year t.
	Change of law charge (L_t)		If a Change of Law occurs after the date upon which this contract shall have been entered into, L_t in any Relevant Year t shall be the Relevant Amount. This amount shall be such as may be agreed between Network Rail and the Train Operator or as may be determined in accordance with any procedure for the arbitration or settlement of disputes provided for in the contract.
	Network Rail Rebate (W_t)	$W_t = RA_t \cdot \frac{F_t}{AF_t}$	
		RA_t	Rebatable amount declared bt Network Rail in relevant Year t

Source: Sánchez-Borràs from:
1) Schedule 7: Track Charges (Doc#175718.01), April 2004
2) Access Charges Review 2003: Regulator's approval of network rail's proposed financing arrangements (Office of the Rail Regulator), 2004
3) Railways Act 1993: Access charges review 2003 (March 2004)
4) Track usage price list (December 2003)
5) List of Capacity Charges Rates (2004/05)
6) Schedule of CC terms (December 2003)

Remark: The UK financial year runs from 1 April to 31 March

(1) Charges indexed by the retail price index.



Banedanmark

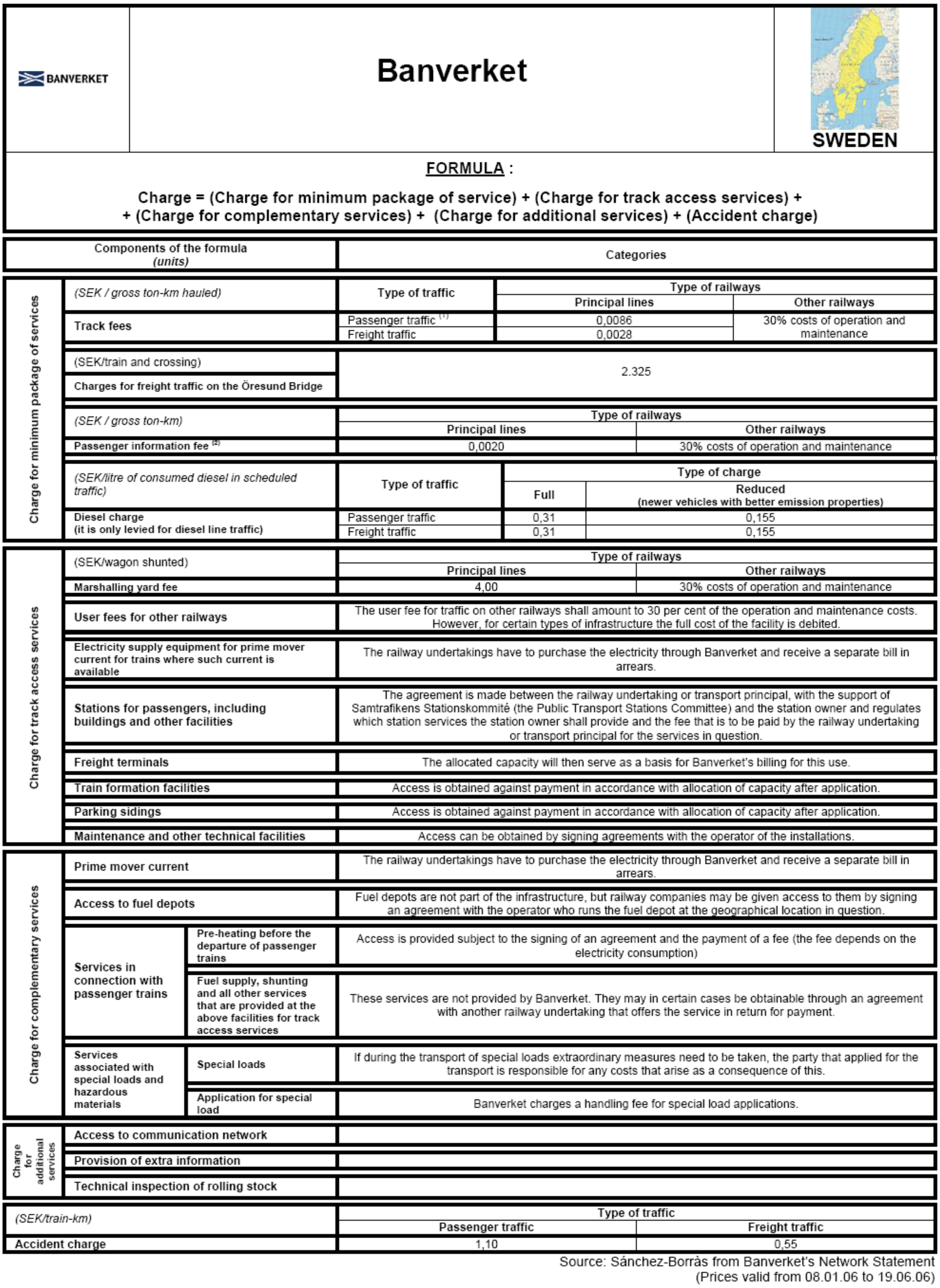
DENMARK

FORMULA :

Rail charge = (Infrastructure charge) + (Capacity charge) + (Additional services charge) +
+ (Supplementary services charge) + (Environmental subsidies) + (Cancellation charge)

Components of the formula (units)				Categories		
Basic services charge	Infrastructure charge	*(DKK per train-km)*				
		Charges per kilometre included supplementary charges for operating on the Danish railway network (with the exception of the Korsør-Nyborg and Öresund Coast- Swedish border lines)		1,84		
		(DKK per train ex. VAT)		Bridge		
				Great Belt	Öresund	
		Tariffs for the use of bridges	Passenger trains	5.679,00	1.781,00	
			Freight trains	5.267,00	2.155,00	
				Remark : Tariff for the use of the Swedish part of the bridge not included		
	Capacity charge	*(DKK per train)*		Link		
				Copenhagen Airport, Kastrup - Kalvebod	Hvidovre Fjern - Høje Taastrup	Vojens - Vamdrup
		Capacity charge for running on the following stretches (exception: cited stations from 7 a.m. to 6.59 p.m.	Passenger trains	310,59	517,65	828,24
			Freight trains	310,59	1.035,29	828,24
Additional services charge						
Supplementary services charge						
Environ-mental subsidies	*(DKK per ton-km conveyed freight)*			0,014		
	Environmental subsidies			Remark : The total deduction must not exceed 50% of the total sales price – VAT not included		
Cancellation charge						

Source: Sánchez-Borràs from Banedanmark's Network Statement 2006
(Valid from 11.12.05 to 09.12.06)



BANVERKET

Banverket

SWEDEN

FORMULA :

Charge = (Charge for minimum package of service) + (Charge for track access services) +
+ (Charge for complementary services) + (Charge for additional services) + (Accident charge)

Components of the formula *(units)*	Categories

Charge for minimum package of services	*(SEK / gross ton-km hauled)*	Type of traffic	Type of railways	
			Principal lines	Other railways
	Track fees	Passenger traffic [1]	0,0086	30% costs of operation and maintenance
		Freight traffic	0,0028	

	(SEK/train and crossing)	2.325
	Charges for freight traffic on the Öresund Bridge	

	(SEK / gross ton-km)	Type of railways	
		Principal lines	Other railways
	Passenger information fee [2]	0,0020	30% costs of operation and maintenance

	(SEK/litre of consumed diesel in scheduled traffic)	Type of traffic	Type of charge	
			Full	Reduced (newer vehicles with better emission properties)
	Diesel charge (it is only levied for diesel line traffic)	Passenger traffic	0,31	0,155
		Freight traffic	0,31	0,155

Charge for track access services	(SEK/wagon shunted)	Type of railways	
		Principal lines	Other railways
	Marshalling yard fee	4,00	30% costs of operation and maintenance

	User fees for other railways	The user fee for traffic on other railways shall amount to 30 per cent of the operation and maintenance costs. However, for certain types of infrastructure the full cost of the facility is debited.
	Electricity supply equipment for prime mover current for trains where such current is available	The railway undertakings have to purchase the electricity through Banverket and receive a separate bill in arrears.
	Stations for passengers, including buildings and other facilities	The agreement is made between the railway undertaking or transport principal, with the support of Samtrafikens Stationskommité (the Public Transport Stations Committee) and the station owner and regulates which station services the station owner shall provide and the fee that is to be paid by the railway undertaking or transport principal for the services in question.
	Freight terminals	The allocated capacity will then serve as a basis for Banverket's billing for this use.
	Train formation facilities	Access is obtained against payment in accordance with allocation of capacity after application.
	Parking sidings	Access is obtained against payment in accordance with allocation of capacity after application.
	Maintenance and other technical facilities	Access can be obtained by signing agreements with the operator of the installations.

Charge for complementary services			
	Prime mover current		The railway undertakings have to purchase the electricity through Banverket and receive a separate bill in arrears.
	Access to fuel depots		Fuel depots are not part of the infrastructure, but railway companies may be given access to them by signing an agreement with the operator who runs the fuel depot at the geographical location in question.
	Services in connection with passenger trains	**Pre-heating before the departure of passenger trains**	Access is provided subject to the signing of an agreement and the payment of a fee (the fee depends on the electricity consumption)
		Fuel supply, shunting and all other services that are provided at the above facilities for track access services	These services are not provided by Banverket. They may in certain cases be obtainable through an agreement with another railway undertaking that offers the service in return for payment.
	Services associated with special loads and hazardous materials	**Special loads**	If during the transport of special loads extraordinary measures need to be taken, the party that applied for the transport is responsible for any costs that arise as a consequence of this.
		Application for special load	Banverket charges a handling fee for special load applications.

Charge for additional services		
	Access to communication network	
	Provision of extra information	
	Technical inspection of rolling stock	

(SEK/train-km)	Type of traffic	
	Passenger traffic	Freight traffic
Accident charge	1,10	0,55

Source: Sánchez-Borràs from Banverket's Network Statement
(Prices valid from 08.01.06 to 19.06.06)

Remark: The *Track Areas* of Banverket are responsible for the charge of use on other railways and costs which the railway undertaking must pay for the services of these other railways.

(1) The passenger trains which do no transport passengers will pay the same charge as freight trains.
(2) The passenger trains which do no transport passengers will not pay the passenger information fee.

ÖBB-Infrastruktur Betrieb AG - Österreichische Bundesbahnen Infrastruktur Betrieb AG

AUSTRIA

FORMULA :

Infrastructure charge = (Charge for train movement) + (Charge for stops at stations) +
+ (Charge for shunting) + (Charge for parking) +
+ (Charge for the use of other facilities) + (Charge for other services)

Components of the formula *(units)*	Categories

Charge for train movement

Infrastructure charge$_{\text{train movement}}$ = (Total gross tonne-km x **a**) + (Train-km line cat. x **b$_{\text{line cat.}}$**) + (Train-km traction unit cat. x **c$_{\text{traction unit cat.}}$**) + (Train-km in bottlenec x **d**) + (Delai in minutes at the stopping station x **e**) + (Train-km$_{\text{market}}$ segment x **f$_{\text{MS}}$**)

Standard package for train movement

Charge for the costs directly incurred	*(€/gross tonne -km)*	**0,001**
	a	

		Line category					
Charge linked to the usage of the lines	*(€/train-km)*	**Secondary lines**	**Kufstein-Innsbruck-Brenner (Brenner axis)**	**Narrow gauge lines**	**Other international axis**	**Other main lines**	**Westbahn**
	b$_l$	0,90	2,73	0,77	1,57	1,18	2,26

		Market segment					
		Freight traffic				E Passenger traffic	F Service runs
Usage charges linked to the type of traffic of the standard package	*(€/train-km)*	A Direct traffic	B Combined traffic	C General traffic	D Transfer traffic		
	f$_l$	0,29	-0,05	-0,05	-0,66	-0,15	-0,04

Mark-ups and discounts (linked to the quality and to the line)

		Traction unit category		
For the wear and tear of tracks caused by traction units	*(€/train-km)*	Category A	Category B	Category C
	c$_l$	-0,04	0,00	0,01

Mark-ups for temporary and local bottlenecks	*(€/train-km)*	1,00
	d	
Charges depending on the performance regime	*(€/min$^{(1)}$)*	3,00
	e	

Additional package

Charge for the movement of trains outside opening hours	Calculated by the *Netzzugang* unit (Access to the Network) on an individual basis

Charge for stops at stations

Infrastructure charge$_{\text{stop at a station}}$ = (Number of stops per station category) x **g$_{\text{station category}}$**

		Station category (Cat$_l$)				
Standar package	*(€/stop)*	Cat. 1	Cat. 2	Cat. 3	Cat. 4	Cat. 5
	g$_l$	5,45	2,60	1,69	0,98	0,00
Additional services		See charges for other services				

Charge for shunting

Standard package – Shunting operations at shunting facilities

Infrastructure charge$_{\text{shunting at shunting facilities}}$ =
(Number of traction units treated x **h**) + (Freight train parked wagons passing through shunting facilities or stopping at those x **i**) + (Hours designed to units shunting for separating and composing passenger trains x **j**) +
+ (Hours of staff preparation for passenger trains x **k**) + (Number of wagons set x **l**) +
+ (Number of shunting train sets > 1 departing train x **m**) + (Number of wagons needing special handling x **n**) +
+ (Number of complete breaking tests carried out x **o**)

Handling of traction units at shunting facilities	*(Price in €)*	15,90
	h	
Separation, composition and preparation of freight trains at shunting facilities	*(€/parked wagon)*	2,30
	i	
	(€/hour)	78,75
	j	
	(€/h preparat.)	10,65
	k	
Allocation of vehicles (passengers and freight)	*(€/coach or wagon)*	3,25
	l	
Shunting train sets	*(€/train set)*	6,00
	m	
Wagons needing a special handling at shunting nodes	*(€/wagon)*	2,35
	n	
Braking test	*(€/test)*	15,90
	o	

ÖBB

ÖBB-Infrastruktur Betrieb AG -
Österreichische Bundesbahnen
Infrastruktur Betrieb AG

AUSTRIA

Infrastructure charge$_{\text{shunting outside shunting facilities}}$ =
= (Number of hours agreed of staff for planned orders x **p**) + (Number of hours agreed of staff for ad hoc orders x **q**) +
+ (Number of hours agreed of staff at facilities not belonging to Betrieb AG x **r**) +
+ (Number of hours agreed of staff for the shunting supervisor service x **s**)

Charges for shunting	**Shunting operations outside shunting facilities**	**At Betrieb AG facilities for planned orders**	*(€/hour)* p	10,65
		At Betrieb AG facilities for ad hoc orders	*(€/hour)* q	34,70
		At facilities not belonging to Betrieb AG's rail infrastructure facilities (private shunting facilities)	*(€/hour)* r	34,70
		Shunting supervisor service, including the traction unit operation (shunting locomotive)	*(€/hour)* s	37,00

Infrastructure charge$_{\text{parking of vehicles}}$ = (Number of days in which the vehicle is parked x $\mathbf{t_1}$) + (Number of track metres x renting period in calendar days x $\mathbf{t_{2t}}$) + (Number of track metres x renting period in months x $\mathbf{t_{2m}}$) + (Number of track metres x $\mathbf{t_{2j}}$) + (Number of vehiles set x **u**)

Charge for parking	**Standard package**	*(€/day and track metres)* t_1	2,25		
	Charge for the renting of tracks linked to the facilities	*(€/track metre)*	Per day (t_{2t})	Per month (t_{2m})	Per year (t_{2j})
		t_2	0,19	4,00	40,00
	Use of public parking tracks for loading/unloading vehicles as agreed and during the time period agreed	*(€/vehicle)* u	0,30		

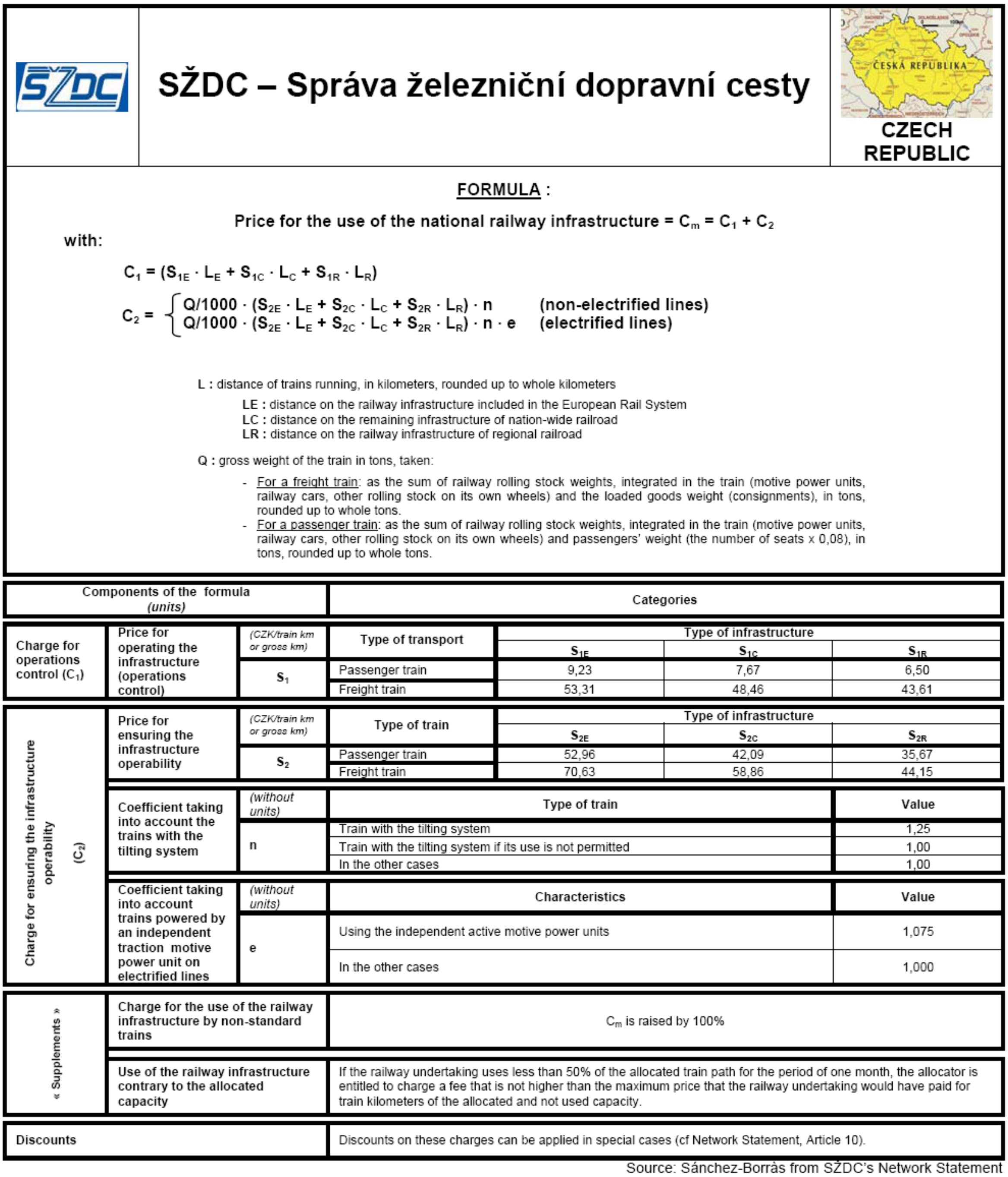
Infrastructure charge$_{\text{other services}}$ = (Number of hours ordered for the use o the preheating system x **v**) +
+ (Number of rail weighing bridges used per year/month/day x $\mathbf{w_{year/month/day}}$) + (Number of weighing systems in movement per year/month/day x $\mathbf{x_{year/month/day}}$)

Charge ofor the use of other facilities	**Facilities for the preheating/air-conditioning of passenger trains**		*(€/hour)* v	0,70		
	Weighing systems	**Rail weighing bridge**	*(Price in €)*	Per year (w_{year})	Per month (w_{month})	Per day (w_{day})
			w_I	12.000,00	1.200,00	60,00
		Weighing systems in movement	*(Price in €)*	Per year (x_{year})	Per month (x_{month})	Per day (x_{day})
			x_I	48.000,00	4.800,00	240,00

		Use of								
Charge for other services	*(€ /hour)*	**Station director**	**Movement inspector**	**Signaler/ Block post/ Crossing gard**	**Shunting staff**	**Trains tester**	**Telex operator / Director**	**Station service staff**	**Shunting supervisor / Driver**	**Rail security staff**
	z_I	47,60	45,70	36,50	35,00	36,60	36,50	34,50	37,20	25,60

Source : Sánchez-Borràs from ÖBB's Network Statement (Track Access Product Catalogue 2006)
(Valid from 11.12.05 to 10.12.06)

(1) Minutes of delay at the stopping station.



SŽDC – Správa železniční dopravní cesty

CZECH REPUBLIC

FORMULA :

Price for the use of the national railway infrastructure = $C_m = C_1 + C_2$

with:

$$C_1 = (S_{1E} \cdot L_E + S_{1C} \cdot L_C + S_{1R} \cdot L_R)$$

$$C_2 = \begin{cases} Q/1000 \cdot (S_{2E} \cdot L_E + S_{2C} \cdot L_C + S_{2R} \cdot L_R) \cdot n & \text{(non-electrified lines)} \\ Q/1000 \cdot (S_{2E} \cdot L_E + S_{2C} \cdot L_C + S_{2R} \cdot L_R) \cdot n \cdot e & \text{(electrified lines)} \end{cases}$$

L : distance of trains running, in kilometers, rounded up to whole kilometers

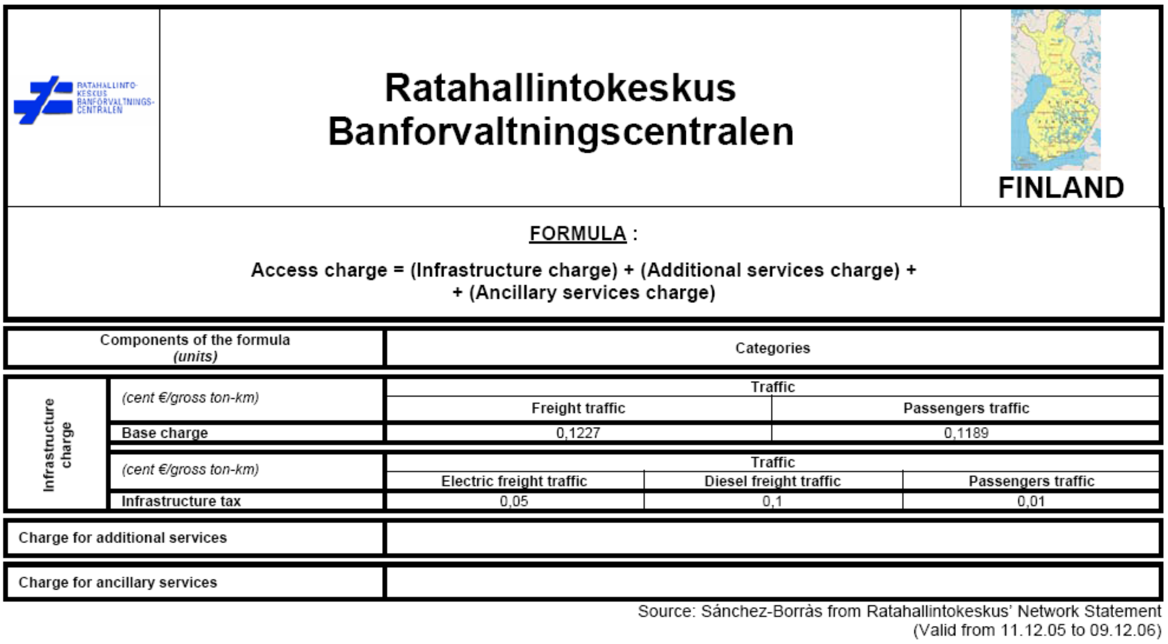
LE : distance on the railway infrastructure included in the European Rail System
LC : distance on the remaining infrastructure of nation-wide railroad
LR : distance on the railway infrastructure of regional railroad

Q : gross weight of the train in tons, taken:

- For a freight train: as the sum of railway rolling stock weights, integrated in the train (motive power units, railway cars, other rolling stock on its own wheels) and the loaded goods weight (consignments), in tons, rounded up to whole tons.
- For a passenger train: as the sum of railway rolling stock weights, integrated in the train (motive power units, railway cars, other rolling stock on its own wheels) and passengers' weight (the number of seats x 0,08), in tons, rounded up to whole tons.

Components of the formula *(units)*			Categories			
Charge for operations control (C_1)	**Price for operating the infrastructure (operations control)**	*(CZK/train km or gross km)*	**Type of transport**	**Type of infrastructure**		
				S_{1E}	**S_{1C}**	**S_{1R}**
		S_1	Passenger train	9,23	7,67	6,50
			Freight train	53,31	48,46	43,61
Charge for ensuring the infrastructure operability (C_2)	**Price for ensuring the infrastructure operability**	*(CZK/train km or gross km)*	**Type of train**	**Type of infrastructure**		
				S_{2E}	**S_{2C}**	**S_{2R}**
		S_2	Passenger train	52,96	42,09	35,67
			Freight train	70,63	58,86	44,15
	Coefficient taking into account the trains with the tilting system	*(without units)*	**Type of train**	**Value**		
		n	Train with the tilting system	1,25		
			Train with the tilting system if its use is not permitted	1,00		
			In the other cases	1,00		
	Coefficient taking into account trains powered by an independent traction motive power unit on electrified lines	*(without units)*	**Characteristics**	**Value**		
		e	Using the independent active motive power units	1,075		
			In the other cases	1,000		
« Supplements »	**Charge for the use of the railway infrastructure by non-standard trains**		C_m is raised by 100%			
	Use of the railway infrastructure contrary to the allocated capacity		If the railway undertaking uses less than 50% of the allocated train path for the period of one month, the allocator is entitled to charge a fee that is not higher than the maximum price that the railway undertaking would have paid for train kilometers of the allocated and not used capacity.			
Discounts			Discounts on these charges can be applied in special cases (cf Network Statement, Article 10).			

Source: Sánchez-Borràs from SŽDC's Network Statement
(Valid from 01.07.05)



Ratahallintokeskus
Banforvaltningscentralen

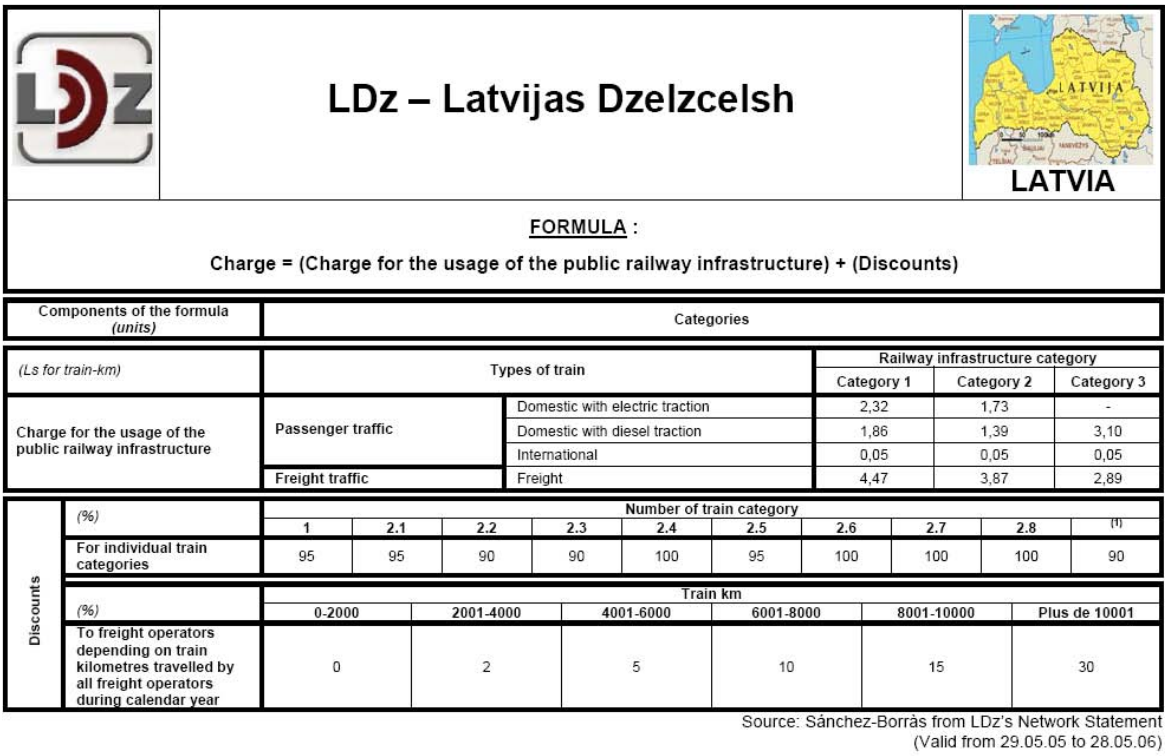
FINLAND

FORMULA :

Access charge = (Infrastructure charge) + (Additional services charge) +
+ (Ancillary services charge)

Components of the formula *(units)*		Categories		
Infrastructure charge	*(cent €/gross ton-km)*	Traffic		
		Freight traffic	Passengers traffic	
	Base charge	0,1227	0,1189	
	(cent €/gross ton-km)	Traffic		
		Electric freight traffic	Diesel freight traffic	Passengers traffic
	Infrastructure tax	0,05	0,1	0,01
Charge for additional services				
Charge for ancillary services				

Source: Sánchez-Borràs from Ratahallintokeskus' Network Statement
(Valid from 11.12.05 to 09.12.06)



LDz – Latvijas Dzelzcelsh

LATVIA

FORMULA :

Charge = (Charge for the usage of the public railway infrastructure) + (Discounts)

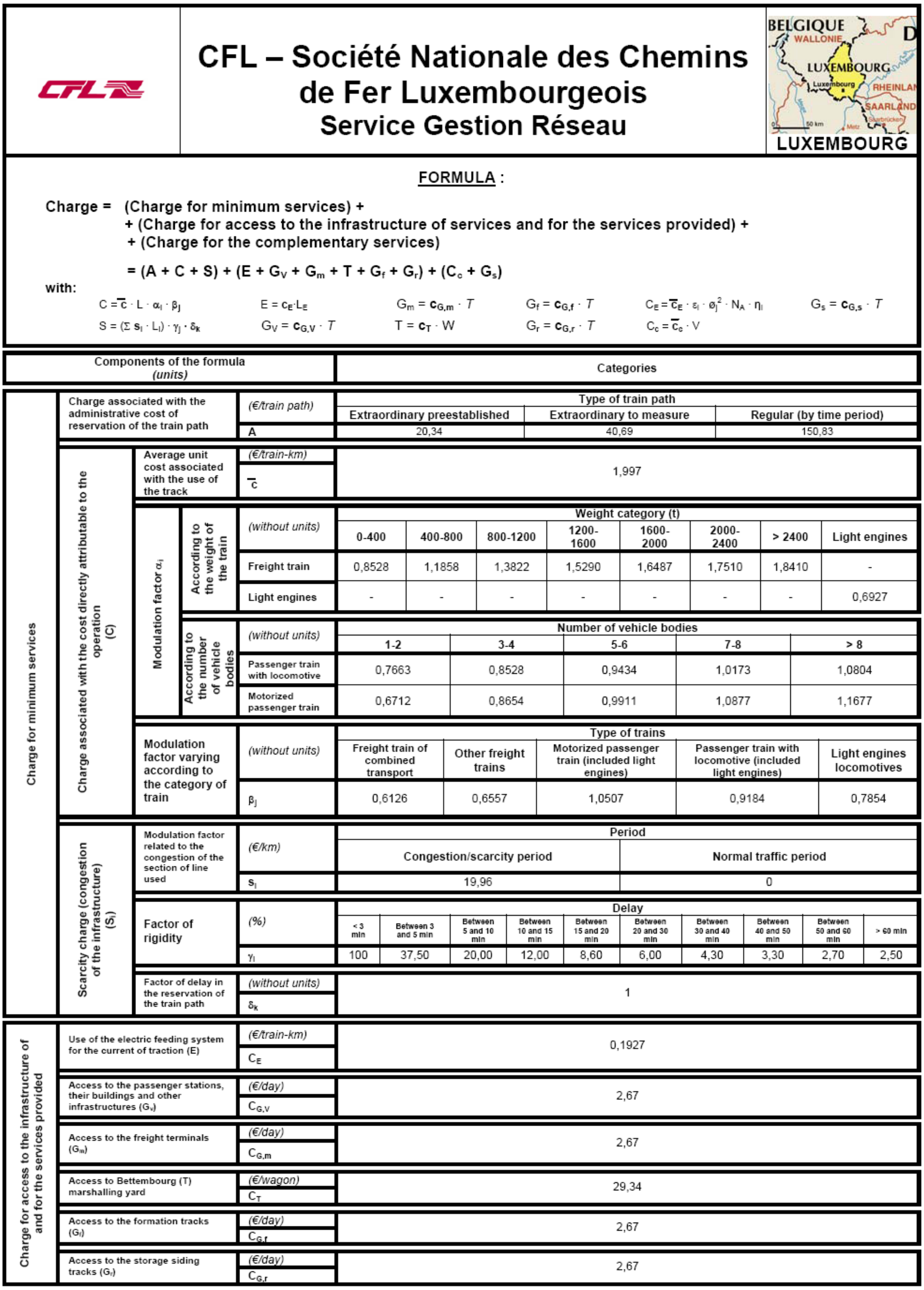
Components of the formula *(units)*	Categories				
(Ls for train-km)	Types of train		Railway infrastructure category		
			Category 1	Category 2	Category 3
Charge for the usage of the public railway infrastructure	Passenger traffic	Domestic with electric traction	2,32	1,73	-
		Domestic with diesel traction	1,86	1,39	3,10
		International	0,05	0,05	0,05
	Freight traffic	Freight	4,47	3,87	2,89

Discounts	*(%)*	Number of train category									
		1	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	(1)
	For individual train categories	95	95	90	90	100	95	100	100	100	90

Discounts	*(%)*	Train km					
		0-2000	2001-4000	4001-6000	6001-8000	8001-10000	Plus de 10001
	To freight operators depending on train kilometres travelled by all freight operators during calendar year	0	2	5	10	15	30

Source: Sánchez-Borràs from LDz's Network Statement
(Valid from 29.05.05 to 28.05.06)

(1) Trains with damaged empty coaches that move towards the deposit for reparation.



CFL – Société Nationale des Chemins de Fer Luxembourgeois
Service Gestion Réseau

FORMULA :

Charge = (Charge for minimum services) +
+ (Charge for access to the infrastructure of services and for the services provided) +
+ (Charge for the complementary services)

$$= (A + C + S) + (E + G_V + G_m + T + G_f + G_r) + (C_c + G_s)$$

with:

$C = \bar{c} \cdot L \cdot \alpha_l \cdot \beta_j$ $\quad E = c_E \cdot L_E$ $\quad G_m = \mathbf{c}_{G,m} \cdot T$ $\quad G_f = \mathbf{c}_{G,f} \cdot T$ $\quad C_E = \bar{c}_E \cdot \varepsilon_l \cdot ø_j^2 \cdot N_A \cdot \eta_l$ $\quad G_s = \mathbf{c}_{G,s} \cdot T$

$S = (\Sigma\, \mathbf{s}_l \cdot L_l) \cdot \gamma_j \cdot \delta_k$ $\quad G_V = \mathbf{c}_{G,V} \cdot T$ $\quad T = \mathbf{c}_T \cdot W$ $\quad G_r = \mathbf{c}_{G,r} \cdot T$ $\quad C_c = \bar{c}_c \cdot V$

Components of the formula *(units)*		Categories

Charge for minimum services

		Type of train path		
Charge associated with the administrative cost of reservation of the train path	*(€/train path)*	Extraordinary preestablished	Extraordinary to measure	Regular (by time period)
	A	20,34	40,69	150,83

Charge associated with the cost directly attributable to the operation (C)

Average unit cost associated with the use of the track	*(€/train-km)* $\bar{c}$	1,997

Modulation factor α_l – According to the weight of the train

	Weight category (t)							
(without units)	0-400	400-800	800-1200	1200-1600	1600-2000	2000-2400	> 2400	Light engines
Freight train	0,8528	1,1858	1,3822	1,5290	1,6487	1,7510	1,8410	-
Light engines	-	-	-	-	-	-	-	0,6927

Modulation factor α_l – According to the number of vehicle bodies

	Number of vehicle bodies				
(without units)	1-2	3-4	5-6	7-8	> 8
Passenger train with locomotive	0,7663	0,8528	0,9434	1,0173	1,0804
Motorized passenger train	0,6712	0,8654	0,9911	1,0877	1,1677

		Type of trains				
Modulation factor varying according to the category of train	*(without units)*	Freight train of combined transport	Other freight trains	Motorized passenger train (included light engines)	Passenger train with locomotive (included light engines)	Light engines locomotives
	β_j	0,6126	0,6557	1,0507	0,9184	0,7854

Scarcity charge (congestion of the infrastructure) (S_l)

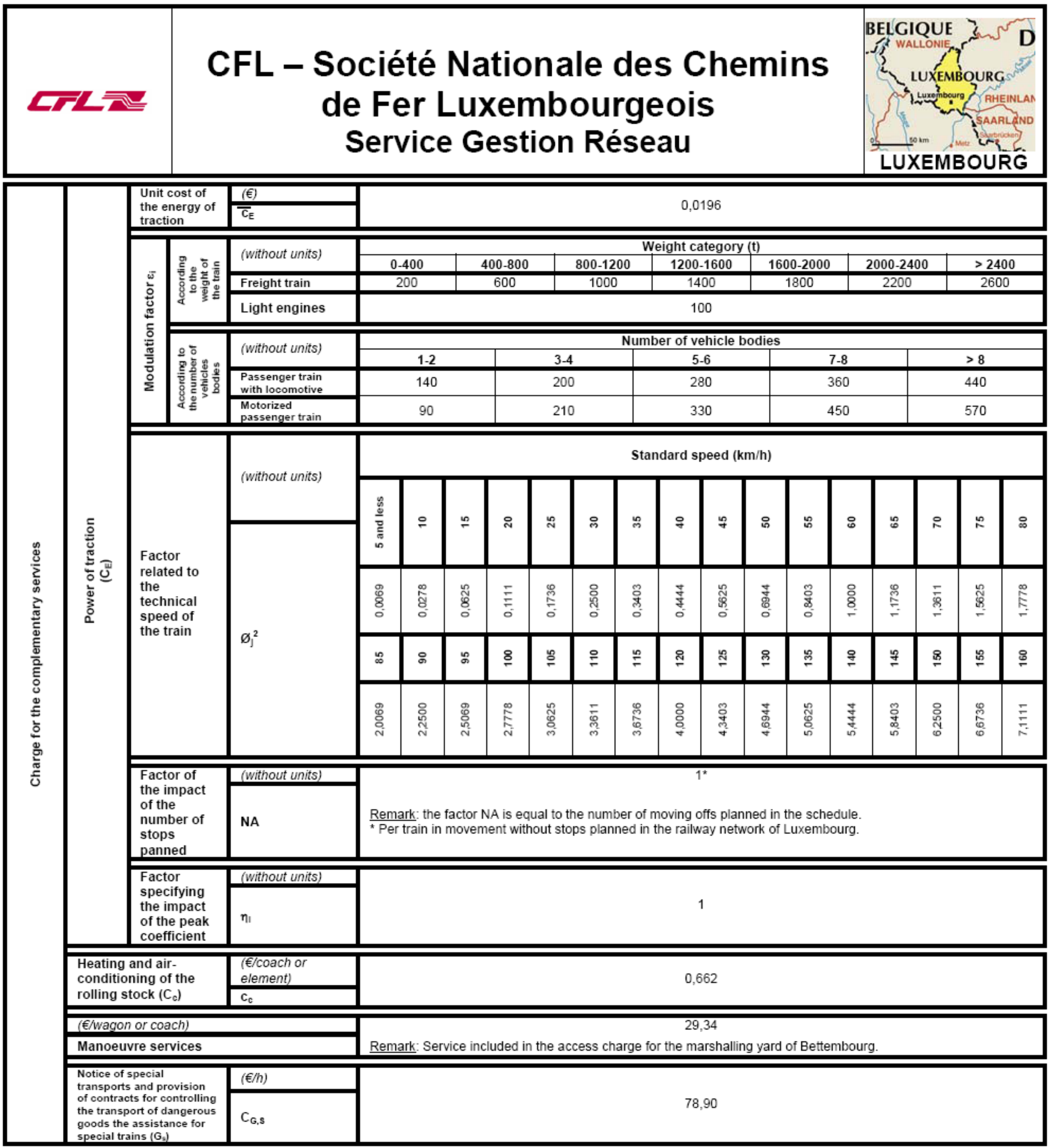
		Period	
Modulation factor related to the congestion of the section of line used	*(€/km)*	Congestion/scarcity period	Normal traffic period
	s_l	19,96	0

		Delay									
Factor of rigidity	*(%)*	< 3 min	Between 3 and 5 min	Between 5 and 10 min	Between 10 and 15 min	Between 15 and 20 min	Between 20 and 30 min	Between 30 and 40 min	Between 40 and 50 min	Between 50 and 60 min	> 60 min
	γ_l	100	37,50	20,00	12,00	8,60	6,00	4,30	3,30	2,70	2,50

Factor of delay in the reservation of the train path	*(without units)* δ_k	1

Charge for access to the infrastructure of and for the services provided

Use of the electric feeding system for the current of traction (E)	*(€/train-km)*	C_E	0,1927
Access to the passenger stations, their buildings and other infrastructures (G_v)	*(€/day)*	$C_{G,V}$	2,67
Access to the freight terminals (G_m)	*(€/day)*	$C_{G,m}$	2,67
Access to Bettembourg (T) marshalling yard	*(€/wagon)*	C_T	29,34
Access to the formation tracks (G_f)	*(€/day)*	$C_{G,f}$	2,67
Access to the storage siding tracks (G_r)	*(€/day)*	$C_{G,r}$	2,67



CFL – Société Nationale des Chemins de Fer Luxembourgeois
Service Gestion Réseau

Charge for the complementary services

Power of traction (C_E)

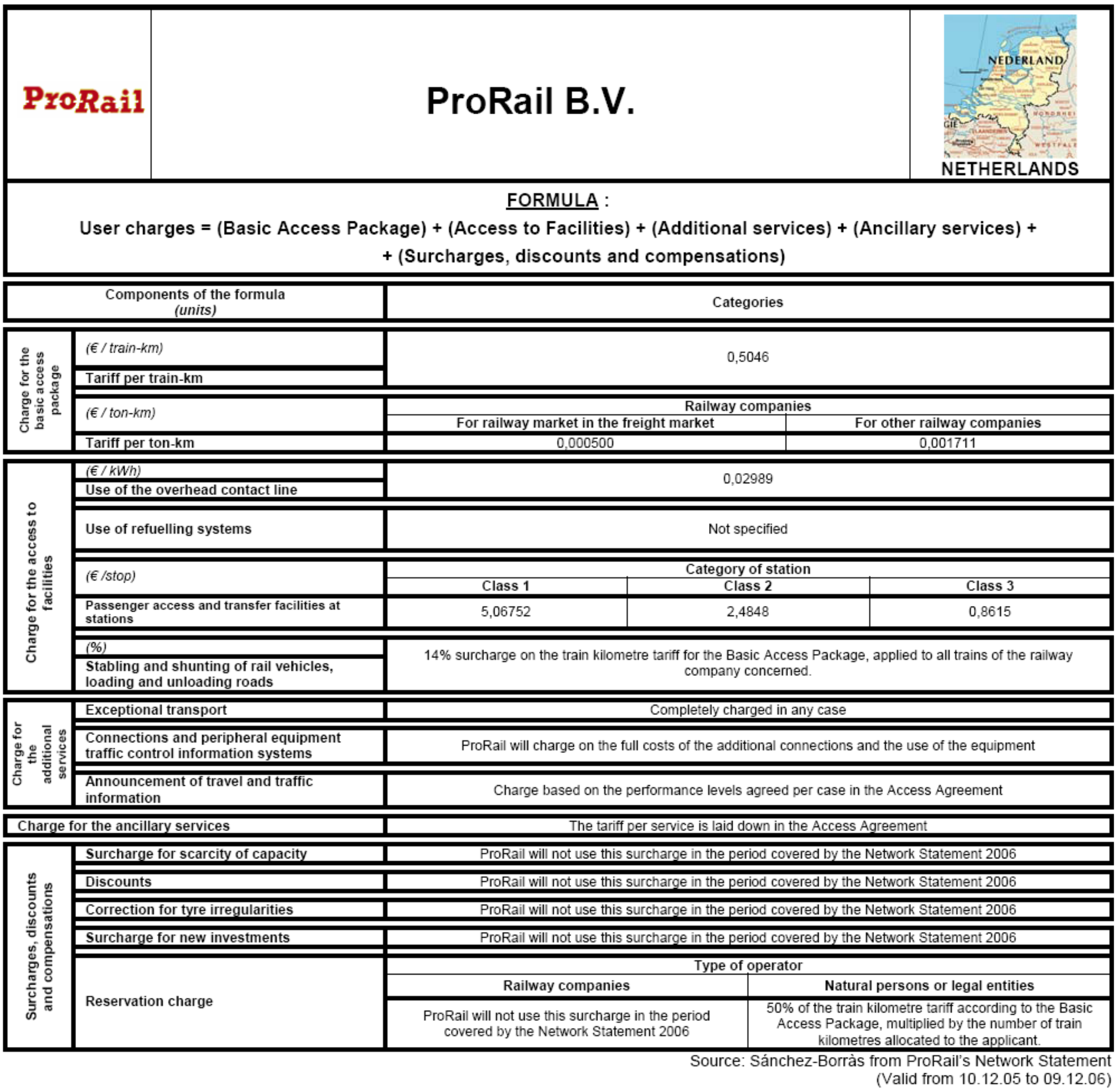
Unit cost of the energy of traction	(€) $\overline{c_E}$	0,0196

Modulation factor ε_i		(without units)	Weight category (t)						
	According to the weight of the train		0-400	400-800	800-1200	1200-1600	1600-2000	2000-2400	> 2400
		Freight train	200	600	1000	1400	1800	2200	2600
		Light engines	100						
	According to the number of vehicles bodies	(without units)	Number of vehicle bodies						
			1-2	3-4	5-6	7-8	> 8		
		Passenger train with locomotive	140	200	280	360	440		
		Motorized passenger train	90	210	330	450	570		

Factor related to the technical speed of the train	(without units)	Standard speed (km/h)															
		5 and less	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80
	$Ø_j^2$	0,0069	0,0278	0,0625	0,1111	0,1736	0,2500	0,3403	0,4444	0,5625	0,6944	0,8403	1,0000	1,1736	1,3611	1,5625	1,7778
		85	90	95	100	105	110	115	120	125	130	135	140	145	150	155	160
		2,0069	2,2500	2,5069	2,7778	3,0625	3,3611	3,6736	4,0000	4,3403	4,6944	5,0625	5,4444	5,8403	6,2500	6,6736	7,1111

Factor of the impact of the number of stops panned	(without units) NA	1* Remark: the factor NA is equal to the number of moving offs planned in the schedule. * Per train in movement without stops planned in the railway network of Luxembourg.
Factor specifying the impact of the peak coefficient	(without units) η_l	1
Heating and air-conditioning of the rolling stock (C_c)	(€/coach or element) c_c	0,662
Manoeuvre services	(€/wagon or coach)	29,34 Remark: Service included in the access charge for the marshalling yard of Bettembourg.
Notice of special transports and provision of contracts for controlling the transport of dangerous goods the assistance for special trains (G_s)	(€/h) $C_{G,S}$	78,90

Source: Sánchez-Borràs from CFL's Network Statement
(Valid from 11.12.05 to 09.12.06)



ProRail

ProRail B.V.

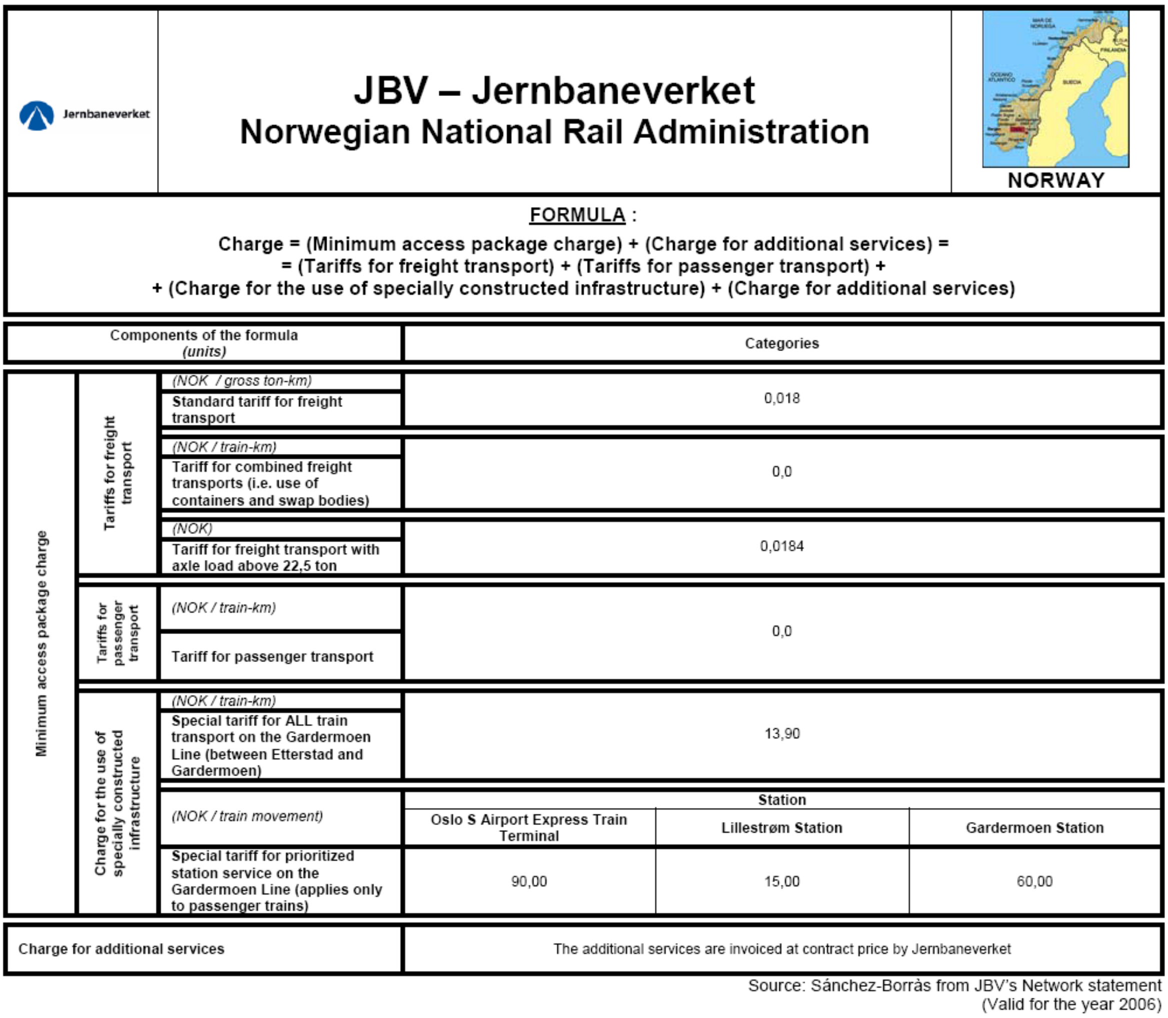
NETHERLANDS

FORMULA :

User charges = (Basic Access Package) + (Access to Facilities) + (Additional services) + (Ancillary services) + + (Surcharges, discounts and compensations)

	Components of the formula *(units)*	Categories		
Charge for the basic access package	*(€ / train-km)* Tariff per train-km	0,5046		
	(€ / ton-km)	Railway companies		
		For railway market in the freight market	For other railway companies	
	Tariff per ton-km	0,000500	0,001711	
Charge for the access to facilities	*(€ / kWh)* Use of the overhead contact line	0,02989		
	Use of refuelling systems	Not specified		
	(€ /stop)	Category of station		
		Class 1	Class 2	Class 3
	Passenger access and transfer facilities at stations	5,06752	2,4848	0,8615
	(%) Stabling and shunting of rail vehicles, loading and unloading roads	14% surcharge on the train kilometre tariff for the Basic Access Package, applied to all trains of the railway company concerned.		
Charge for the additional services	Exceptional transport	Completely charged in any case		
	Connections and peripheral equipment traffic control information systems	ProRail will charge on the full costs of the additional connections and the use of the equipment		
	Announcement of travel and traffic information	Charge based on the performance levels agreed per case in the Access Agreement		
Charge for the ancillary services		The tariff per service is laid down in the Access Agreement		
Surcharges, discounts and compensations	Surcharge for scarcity of capacity	ProRail will not use this surcharge in the period covered by the Network Statement 2006		
	Discounts	ProRail will not use this surcharge in the period covered by the Network Statement 2006		
	Correction for tyre irregularities	ProRail will not use this surcharge in the period covered by the Network Statement 2006		
	Surcharge for new investments	ProRail will not use this surcharge in the period covered by the Network Statement 2006		
	Reservation charge	Type of operator		
		Railway companies	Natural persons or legal entities	
		ProRail will not use this surcharge in the period covered by the Network Statement 2006	50% of the train kilometre tariff according to the Basic Access Package, multiplied by the number of train kilometres allocated to the applicant.	

Source: Sánchez-Borràs from ProRail's Network Statement (Valid from 10.12.05 to 09.12.06)



Jernbaneverket

JBV – Jernbaneverket
Norwegian National Rail Administration

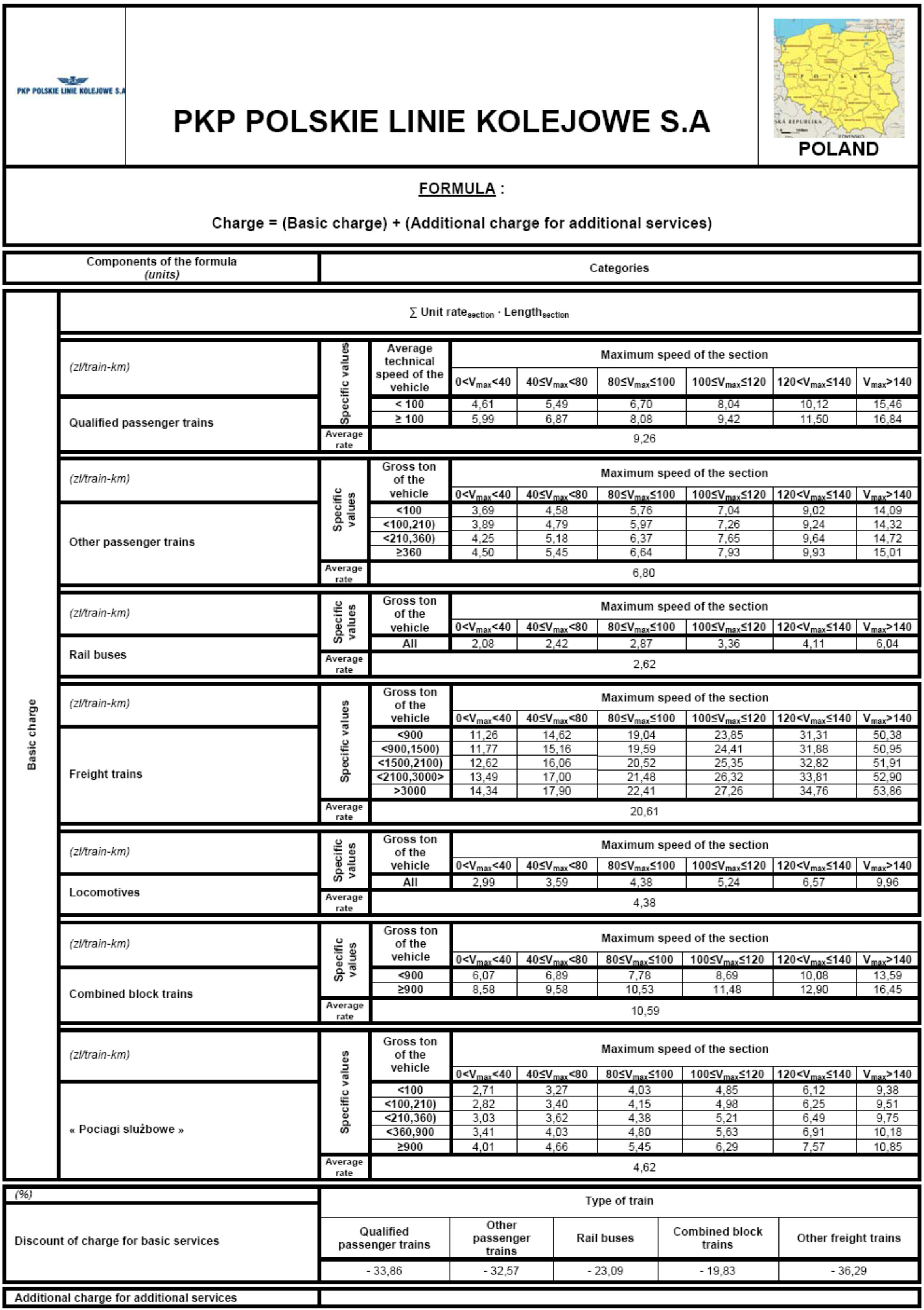
NORWAY

FORMULA :

Charge = (Minimum access package charge) + (Charge for additional services) =
= (Tariffs for freight transport) + (Tariffs for passenger transport) +
+ (Charge for the use of specially constructed infrastructure) + (Charge for additional services)

Components of the formula *(units)*			Categories		
Minimum access package charge	Tariffs for freight transport	*(NOK / gross ton-km)* Standard tariff for freight transport	0,018		
		(NOK / train-km) Tariff for combined freight transports (i.e. use of containers and swap bodies)	0,0		
		(NOK) Tariff for freight transport with axle load above 22,5 ton	0,0184		
	Tariffs for passenger transport	*(NOK / train-km)* Tariff for passenger transport	0,0		
	Charge for the use of specially constructed infrastructure	*(NOK / train-km)* Special tariff for ALL train transport on the Gardermoen Line (between Etterstad and Gardermoen)	13,90		
		(NOK / train movement)	Station		
			Oslo S Airport Express Train Terminal	Lillestrøm Station	Gardermoen Station
		Special tariff for prioritized station service on the Gardermoen Line (applies only to passenger trains)	90,00	15,00	60,00
Charge for additional services			The additional services are invoiced at contract price by Jernbaneverket		

Source: Sánchez-Borràs from JBV's Network statement
(Valid for the year 2006)



PKP POLSKIE LINIE KOLEJOWE S.A

PKP POLSKIE LINIE KOLEJOWE S.A

POLAND

FORMULA :

Charge = (Basic charge) + (Additional charge for additional services)

Components of the formula *(units)*	Categories

Basic charge

$\sum$ Unit rate$_{section}$ · Length$_{section}$

Qualified passenger trains *(zl/train-km)*

Specific values: Average technical speed of the vehicle	Maximum speed of the section					
	$0<V_{max}<40$	$40\le V_{max}<80$	$80\le V_{max}\le 100$	$100\le V_{max}\le 120$	$120<V_{max}\le 140$	$V_{max}>140$
< 100	4,61	5,49	6,70	8,04	10,12	15,46
≥ 100	5,99	6,87	8,08	9,42	11,50	16,84
Average rate	9,26					

Other passenger trains *(zl/train-km)*

Specific values: Gross ton of the vehicle	Maximum speed of the section					
	$0<V_{max}<40$	$40\le V_{max}<80$	$80\le V_{max}\le 100$	$100\le V_{max}\le 120$	$120<V_{max}\le 140$	$V_{max}>140$
<100	3,69	4,58	5,76	7,04	9,02	14,09
<100,210)	3,89	4,79	5,97	7,26	9,24	14,32
<210,360)	4,25	5,18	6,37	7,65	9,64	14,72
≥360	4,50	5,45	6,64	7,93	9,93	15,01
Average rate	6,80					

Rail buses *(zl/train-km)*

Specific values: Gross ton of the vehicle	Maximum speed of the section					
	$0<V_{max}<40$	$40\le V_{max}<80$	$80\le V_{max}\le 100$	$100\le V_{max}\le 120$	$120<V_{max}\le 140$	$V_{max}>140$
All	2,08	2,42	2,87	3,36	4,11	6,04
Average rate	2,62					

Freight trains *(zl/train-km)*

Specific values: Gross ton of the vehicle	Maximum speed of the section					
	$0<V_{max}<40$	$40\le V_{max}<80$	$80\le V_{max}\le 100$	$100\le V_{max}\le 120$	$120<V_{max}\le 140$	$V_{max}>140$
<900	11,26	14,62	19,04	23,85	31,31	50,38
<900,1500)	11,77	15,16	19,59	24,41	31,88	50,95
<1500,2100)	12,62	16,06	20,52	25,35	32,82	51,91
<2100,3000>	13,49	17,00	21,48	26,32	33,81	52,90
>3000	14,34	17,90	22,41	27,26	34,76	53,86
Average rate	20,61					

Locomotives *(zl/train-km)*

Specific values: Gross ton of the vehicle	Maximum speed of the section					
	$0<V_{max}<40$	$40\le V_{max}<80$	$80\le V_{max}\le 100$	$100\le V_{max}\le 120$	$120<V_{max}\le 140$	$V_{max}>140$
All	2,99	3,59	4,38	5,24	6,57	9,96
Average rate	4,38					

Combined block trains *(zl/train-km)*

Specific values: Gross ton of the vehicle	Maximum speed of the section					
	$0<V_{max}<40$	$40\le V_{max}<80$	$80\le V_{max}\le 100$	$100\le V_{max}\le 120$	$120<V_{max}\le 140$	$V_{max}>140$
<900	6,07	6,89	7,78	8,69	10,08	13,59
≥900	8,58	9,58	10,53	11,48	12,90	16,45
Average rate	10,59					

« Pociagi służbowe » *(zl/train-km)*

Specific values: Gross ton of the vehicle	Maximum speed of the section					
	$0<V_{max}<40$	$40\le V_{max}<80$	$80\le V_{max}\le 100$	$100\le V_{max}\le 120$	$120<V_{max}\le 140$	$V_{max}>140$
<100	2,71	3,27	4,03	4,85	6,12	9,38
<100,210)	2,82	3,40	4,15	4,98	6,25	9,51
<210,360)	3,03	3,62	4,38	5,21	6,49	9,75
<360,900	3,41	4,03	4,80	5,63	6,91	10,18
≥900	4,01	4,66	5,45	6,29	7,57	10,85
Average rate	4,62					

Discount of charge for basic services *(%)*

Type of train				
Qualified passenger trains	Other passenger trains	Rail buses	Combined block trains	Other freight trains
- 33,86	- 32,57	- 23,09	- 19,83	- 36,29

Additional charge for additional services	

Source: Sánchez-Borràs from PKP PLK's Network Statement and Price List 2006
(Valid from 10.12.05 to 09.12.06)

Remark: Data translated from the Price List 2006, only available in Polish. To confirm if additional comments should be added.

REFER EP

PORTUGAL

FORMULA :

Tariffs = (Tariffs for essential train services) + (Tariffs for additional services) +
+ (Ancillary service tariffs) + (Other tariffs)

Components of the formula *(units)*		Categories							
Tariffs for essential train services	*(€/train-km)*	**Lines**	**Extents**	**Electrified route**			**Non-electrified route**		
				Passengers and empty	**Freight**	**Extension (km)**	**Passengers and empty**	**Freight**	**Extension (km)**
	Basic tariffs	Minho	L.Minho	3,15	3,59	41,6	2,46	3,50	92,8
		Guimarães e Braga	L.Fuimarães + R.Braga	1,23	1,52	30,3+14,9			
		Leixões	L.Leixões + C.S.Gemil	1,50	1,90	18,7+3,8			
		Douro	L.Douro	1,23	1,52	37,7	2,87	3,97	125,4
		Norte	L.Norte – até Azambuja + B.Xabregas	1,14	1,33	46,9+1,7			
		Norte	L.Norte – Azambuja / Aveiro + R.Alfarelos + R.Tomar	1,22	1,52	225,9+ 14,7+14,7			
		Norte	L.Norte – Aveiro / Porto	1,40	1,66	63,3			
		Beira Alta	L.Beira Alta	1,57	2,10	201,8			
		Oeste	L.Oeste + R.Fig.Foz + c.Verride	2,01	2,35	27,1+0 +2,4	1,54	2,20	170,7+ 50,4+0
		Beira Baixa	L.Beira Baixa	1,65	1,99	44,0	1,53	2,20	196,3
		Leste	L.Leste + R.Cáceres				1,12	1,66	140,7+ 72,4
		Sintra	L.Sintra + C.Sete Rios	1,13	1,38	27,2+3,1			
		Cintura	L.Cintura	2,01	2,41	10,3			
		Cascais	L.Cascais	1,13	1,57	25,4			
		Vendas Novas	L.Vendas Novas + C.Bombel + C.Norte Setil	0,79	0,86	65,5+3,6 +1,0	1,25	2,11	4,1+0+0
		Alentejo	L.Alentejo + L.Évora	1,39	1,55	47,5+0	1,26	1,54	168,4+ 85,1
		Sul	L.Sul – jusqu'à Praias Sado	1,67	2,14	55,1			
		Sul	L.Sul – au-delà de Paias Sado + C.Poceirão + C.Agualva + C.Ág.Moura + C.Funcheira	0,87	1,05	218,1+8,2+ 2,6+3,9 +2,4			
		Sines	L.Sines	2,68	3,15	50,8			
		Algarve	L.Algarve	0,87	1,05	38,1	1,43	2,00	101,4

	Case		
	If an RU does not use a valid allocation path, and which it had not asked to be cancelled with the required 48 hours notice	**If an RU cancels an allocation path with more than 48 hours notice but less than 30 days notice**	**If an RU cancels an allocation path with more than 30 days notice**
Supplementary tariffs	It is bound to pay a supplement equal in value to the respective usage rate. This rule does not apply to cases arising from traffic regulations caused by the command posts.	It is bound to pay a supplement equal to 75% of the value of the usage rate	It will not be bound to make any supplementary payment

Tariffs for additional services

Traction power	The costs of electrical energy for traction are fully paid by users, with the costs being calculated according to the actual usage

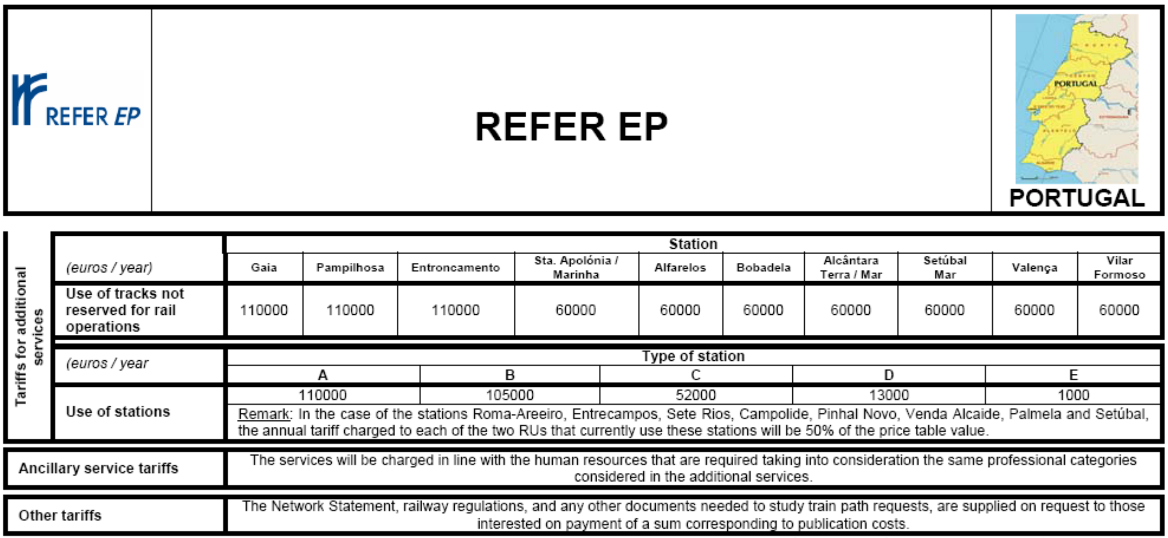
(euros/hour)

Shunting

Professional category													
Operational – Operations area					**Operational – Infrastructure area**			**Operational – Infrastructure area – Track**			**Operational – Support area**	**Operational support – Warehousing**	
Traffic inspector	**Traffic controller**	**Traffic operator**	**Shunting worker**	**Level crossing guard**	**Infrastructure supervisor**	**Master of works – Track**	**Infrastructure worker**	**Track supervisor**	**Master of works – Track**	**Track worker**	**Ancillary worker**	**Warehouseman**	**Warehouse worker**
26,74	20,10	16,74	15,78	12,65	25,41	20,67	18,96	23,60	18,37	16,21	13,83	20,64	14,24
Operational support – Driving	**Operational support – Topography area**	**Operational support – Design area**			**Administrative**			**Skilled workers**			**Graduates**		
Light vehicle driver	**Topographer**	**Draughtsman supervisor**	**Draughtsman I**	**Draughtsman II**	**Back office worker**	**Office clerk**	**Administrative worker**	**Skilled worker I**	**Skilled worker II**	**Skilled worker III**	**Graduate I**	**Graduate II**	**Graduate III**
16,13	25,00	25,11	21,66	17,74	23,26	17,81	14,92	32,55	25,03	19,37	65,76	53,23	35,75

Remark: These services will be the object of contracts or protocols with each individual RU.

(euros/calendar days)	
Parking of rolling stock (P_e)	10,00



REFER EP

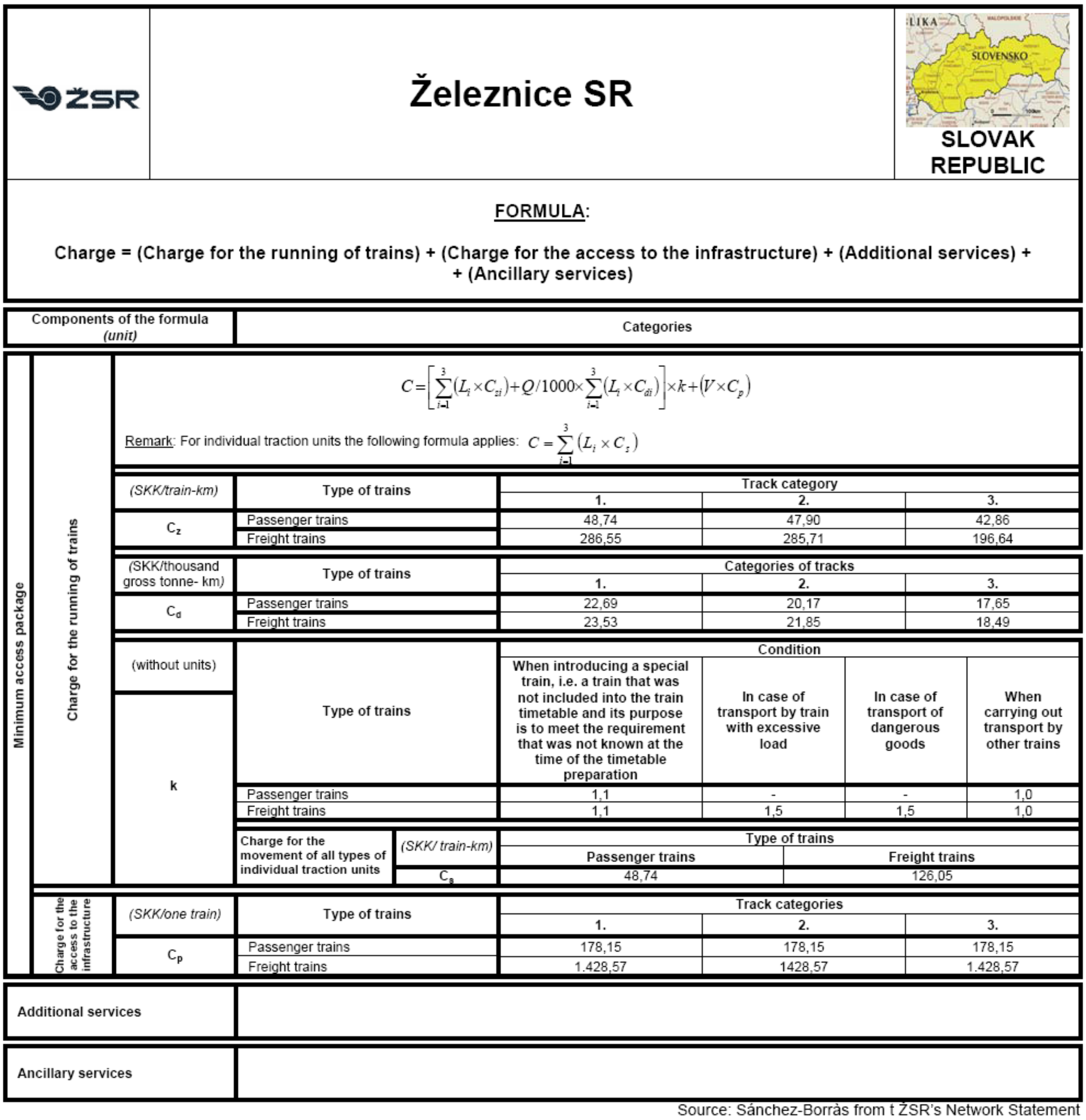
PORTUGAL

		Station									
	(euros / year)	Gaia	Pampilhosa	Entroncamento	Sta. Apolónia / Marinha	Alfarelos	Bobadela	Alcântara Terra / Mar	Setúbal Mar	Valença	Vilar Formoso
Tariffs for additional services	**Use of tracks not reserved for rail operations**	110000	110000	110000	60000	60000	60000	60000	60000	60000	60000

		Type of station				
	(euros / year	A	B	C	D	E
Tariffs for additional services	**Use of stations**	110000	105000	52000	13000	1000
		<u>Remark</u>: In the case of the stations Roma-Areeiro, Entrecampos, Sete Rios, Campolide, Pinhal Novo, Venda Alcaide, Palmela and Setúbal, the annual tariff charged to each of the two RUs that currently use these stations will be 50% of the price table value.				

Ancillary service tariffs	The services will be charged in line with the human resources that are required taking into consideration the same professional categories considered in the additional services.
Other tariffs	The Network Statement, railway regulations, and any other documents needed to study train path requests, are supplied on request to those interested on payment of a sum corresponding to publication costs.

Source: Sánchez-Borràs from REFER's Network Statement (valid for the year 2005)



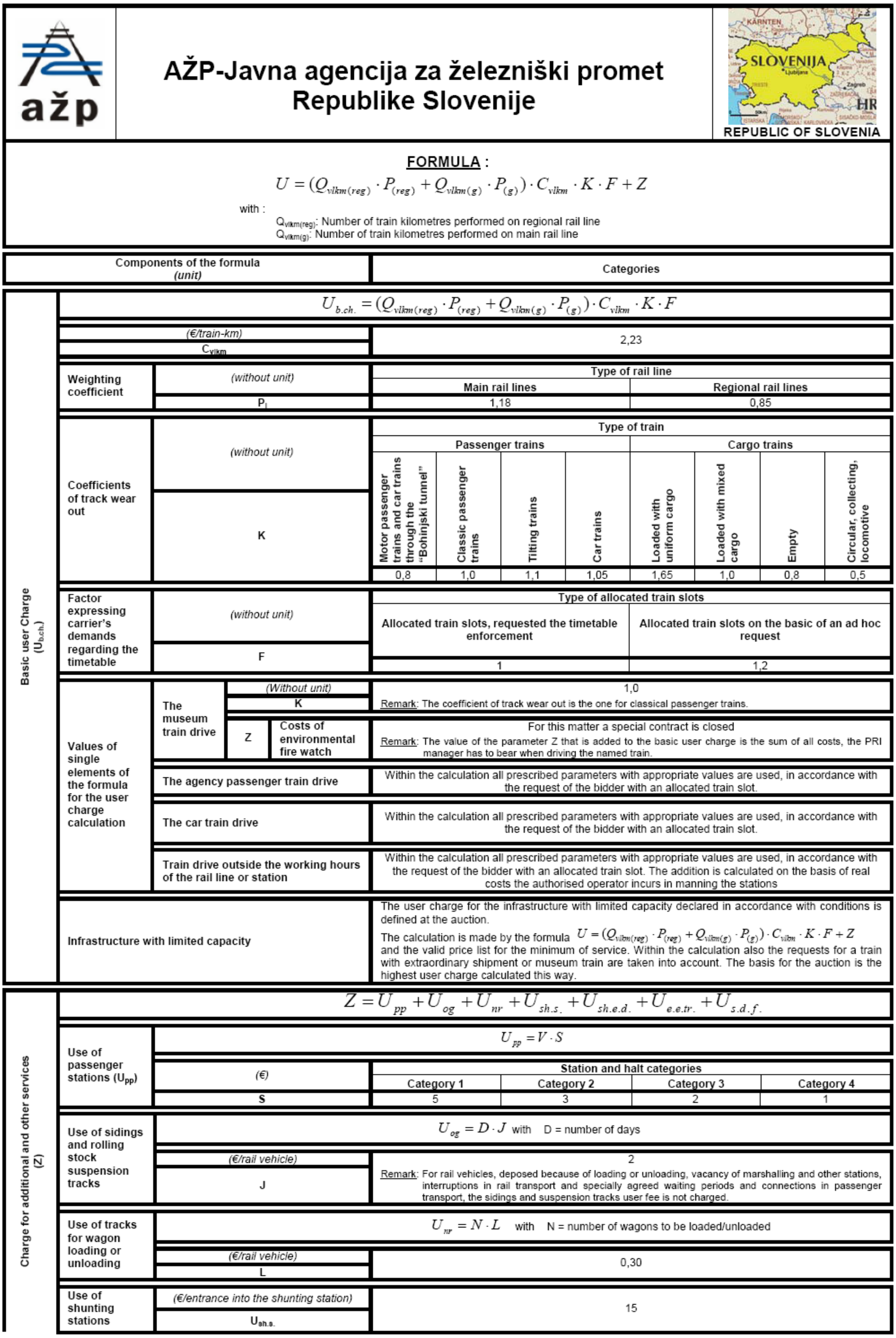
ŽSR	**Železnice SR**	**SLOVAK REPUBLIC**

FORMULA:

Charge = (Charge for the running of trains) + (Charge for the access to the infrastructure) + (Additional services) + + (Ancillary services)

Components of the formula *(unit)*			Categories				
Minimum access package	Charge for the running of trains	$C=\left[\sum_{i=1}^{3}(L_i\times C_{zi})+Q/1000\times\sum_{i=1}^{3}(L_i\times C_{di})\right]\times k+(V\times C_p)$ Remark: For individual traction units the following formula applies: $C=\sum_{i=1}^{3}(L_i\times C_s)$					
		(SKK/train-km)	**Type of trains**	**Track category**			
				1.	**2.**	**3.**	
		C_z	Passenger trains	48,74	47,90	42,86	
			Freight trains	286,55	285,71	196,64	
		(SKK/thousand gross tonne- km)	**Type of trains**	**Categories of tracks**			
				1.	**2.**	**3.**	
		C_d	Passenger trains	22,69	20,17	17,65	
			Freight trains	23,53	21,85	18,49	
		(without units)	**Type of trains**	**Condition**			
				When introducing a special train, i.e. a train that was not included into the train timetable and its purpose is to meet the requirement that was not known at the time of the timetable preparation	**In case of transport by train with excessive load**	**In case of transport of dangerous goods**	**When carrying out transport by other trains**
		k	Passenger trains	1,1	-	-	1,0
			Freight trains	1,1	1,5	1,5	1,0
			Charge for the movement of all types of individual traction units *(SKK/ train-km)*	**Type of trains**			
				Passenger trains		**Freight trains**	
			C_s	48,74		126,05	
	Charge for the access to the infrastructure	*(SKK/one train)*	**Type of trains**	**Track categories**			
				1.	**2.**	**3.**	
		C_p	Passenger trains	178,15	178,15	178,15	
			Freight trains	1.428,57	1428,57	1.428,57	
Additional services							
Ancillary services							

Source: Sánchez-Borràs from t ŽSR's Network Statement
(Prices valid from 01.01.06 to 31.12.06)



ažp

AŽP-Javna agencija za železniški promet Republike Slovenije

REPUBLIC OF SLOVENIA

FORMULA :

$$U = (Q_{vlkm(reg)} \cdot P_{(reg)} + Q_{vlkm(g)} \cdot P_{(g)}) \cdot C_{vlkm} \cdot K \cdot F + Z$$

with :

$Q_{vlkm(reg)}$: Number of train kilometres performed on regional rail line
$Q_{vlkm(g)}$: Number of train kilometres performed on main rail line

Components of the formula *(unit)*	Categories

Basic user Charge ($U_{b.ch.}$)

$$U_{b.ch.} = (Q_{vlkm(reg)} \cdot P_{(reg)} + Q_{vlkm(g)} \cdot P_{(g)}) \cdot C_{vlkm} \cdot K \cdot F$$

(€/train-km)	2,23
C_{vlkm}	

Weighting coefficient	*(without unit)*	**Type of rail line**	
		Main rail lines	**Regional rail lines**
	P_l	1,18	0,85

Coefficients of track wear out	*(without unit)*	**Type of train**							
		Passenger trains				**Cargo trains**			
	K	**Motor passenger trains and car trains through the "Bohinjski tunnel"**	**Classic passenger trains**	**Tilting trains**	**Car trains**	**Loaded with uniform cargo**	**Loaded with mixed cargo**	**Empty**	**Circular, collecting, locomotive**
		0,8	1,0	1,1	1,05	1,65	1,0	0,8	0,5

Factor expressing carrier's demands regarding the timetable	*(without unit)*	**Type of allocated train slots**	
		Allocated train slots, requested the timetable enforcement	**Allocated train slots on the basic of an ad hoc request**
	F	1	1,2

Values of single elements of the formula for the user charge calculation	**The museum train drive**	*(Without unit)* K		1,0 Remark: The coefficient of track wear out is the one for classical passenger trains.
		Z	**Costs of environmental fire watch**	For this matter a special contract is closed Remark: The value of the parameter Z that is added to the basic user charge is the sum of all costs, the PRI manager has to bear when driving the named train.
	The agency passenger train drive			Within the calculation all prescribed parameters with appropriate values are used, in accordance with the request of the bidder with an allocated train slot.
	The car train drive			Within the calculation all prescribed parameters with appropriate values are used, in accordance with the request of the bidder with an allocated train slot.
	Train drive outside the working hours of the rail line or station			Within the calculation all prescribed parameters with appropriate values are used, in accordance with the request of the bidder with an allocated train slot. The addition is calculated on the basis of real costs the authorised operator incurs in manning the stations

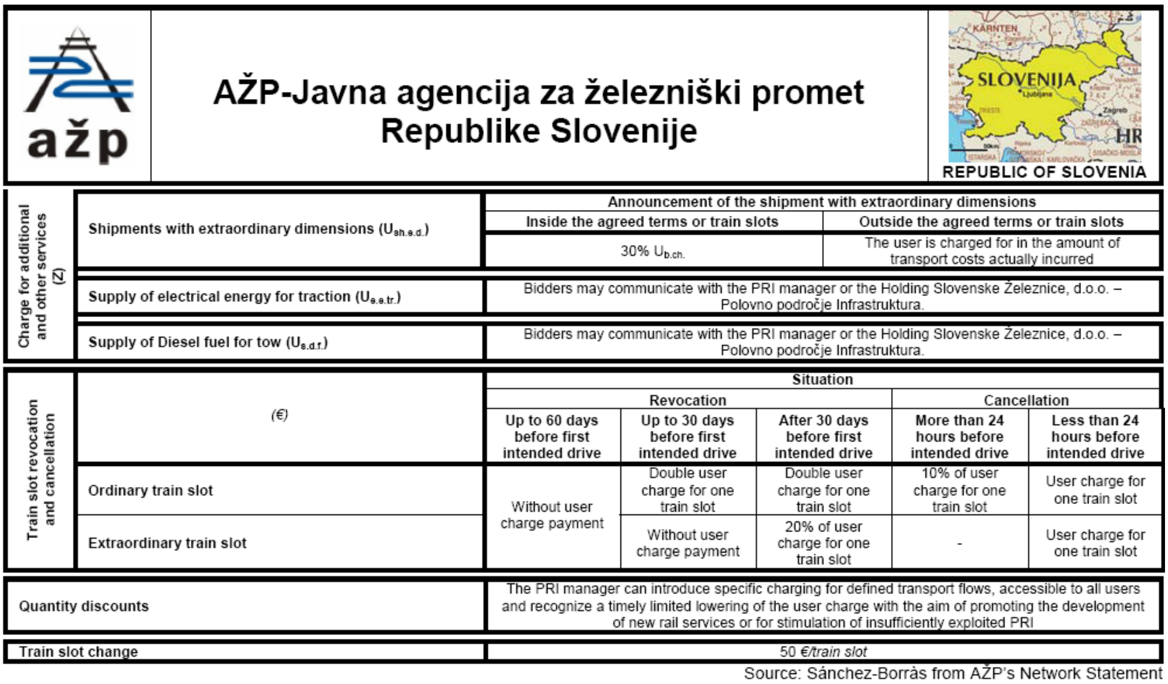
Infrastructure with limited capacity	The user charge for the infrastructure with limited capacity declared in accordance with conditions is defined at the auction. The calculation is made by the formula $U = (Q_{vlkm(reg)} \cdot P_{(reg)} + Q_{vlkm(g)} \cdot P_{(g)}) \cdot C_{vlkm} \cdot K \cdot F + Z$ and the valid price list for the minimum of service. Within the calculation also the requests for a train with extraordinary shipment or museum train are taken into account. The basis for the auction is the highest user charge calculated this way.

Charge for additional and other services (Z)

$$Z = U_{pp} + U_{og} + U_{nr} + U_{sh.s.} + U_{sh.e.d.} + U_{e.e.tr.} + U_{s.d.f.}$$

Use of passenger stations (U_{pp})	$U_{pp} = V \cdot S$				
	(€)	**Station and halt categories**			
		Category 1	**Category 2**	**Category 3**	**Category 4**
	S	5	3	2	1

Use of sidings and rolling stock suspension tracks	$U_{og} = D \cdot J$ with D = number of days	
	(€/rail vehicle) J	2 Remark: For rail vehicles, deposed because of loading or unloading, vacancy of marshalling and other stations, interruptions in rail transport and specially agreed waiting periods and connections in passenger transport, the sidings and suspension tracks user fee is not charged.
Use of tracks for wagon loading or unloading	$U_{nr} = N \cdot L$ with N = number of wagons to be loaded/unloaded	
	(€/rail vehicle) L	0,30
Use of shunting stations	*(€/entrance into the shunting station)* $U_{sh.s.}$	15



AŽP-Javna agencija za železniški promet Republike Slovenije

		Announcement of the shipment with extraordinary dimensions	
		Inside the agreed terms or train slots	Outside the agreed terms or train slots
Charge for additional and other services (Z)	Shipments with extraordinary dimensions ($U_{sh.e.d.}$)	30% $U_{b.ch.}$	The user is charged for in the amount of transport costs actually incurred
	Supply of electrical energy for traction ($U_{e.e.tr.}$)	Bidders may communicate with the PRI manager or the Holding Slovenske Železnice, d.o.o. – Polovno področje Infrastruktura.	
	Supply of Diesel fuel for tow ($U_{s.d.f.}$)	Bidders may communicate with the PRI manager or the Holding Slovenske Železnice, d.o.o. – Polovno področje Infrastruktura.	

		Situation				
		Revocation			Cancellation	
	(€)	Up to 60 days before first intended drive	Up to 30 days before first intended drive	After 30 days before first intended drive	More than 24 hours before intended drive	Less than 24 hours before intended drive
Train slot revocation and cancellation	Ordinary train slot	Without user charge payment	Double user charge for one train slot	Double user charge for one train slot	10% of user charge for one train slot	User charge for one train slot
	Extraordinary train slot		Without user charge payment	20% of user charge for one train slot	-	User charge for one train slot

Quantity discounts	The PRI manager can introduce specific charging for defined transport flows, accessible to all users and recognize a timely limited lowering of the user charge with the aim of promoting the development of new rail services or for stimulation of insufficiently exploited PRI
Train slot change	*50 €/train slot*

Source: Sánchez-Borràs from AŽP's Network Statement
(Prices valid from 10.12.06 to 08.12.07)

Remark: · Exchange rate ERM/2 1 € = 239,64 SIT

· Passenger transport: in the model of calculating the charge for use of the PRI in the year 2007 the carrier of internal passenger transport, according to the contract on managing OGJS, is freed from paying the charge for the allocated train slots on the PRI. The user charge will however be charged for allocated international passenger train slots.

· Cargo transport: in the charging model for the user charge for use of the PRI for the year 2007, it is foreseen that charging will only be applied to transports in international cargo rail transport on lines of the PRI which are part of Tans European railway cargo networks – TERFN in accordance with the point 3. Art. 9 of the Directive 2001/14/ES.

SBB CFF FFS
bls
RM Regionalverkehr Mittelland

SBB – Schweizerische Bundesbahnen
BLS
RM – Regionalverkehr Mittelland

SWITZERLAND

FORMULA :

Charge = (Charge for basic services) + (Charge for supplementary services) + (Charge for miscellaneous services)

Components of the formula *(units)*			Categories	
Charge for basic services	Minimum price	*(CHF/gross ton-km)*	Type of traffic	
			For intermodal goods traffic	For all other types of traffic
		Maintenance	0,0010	0,0025
		(CHF/train-km)	0,4000	
		Train operation service		
		(CHF/ gross ton -km)	See "Energy cost rates and standard values"	
		Purchase of energy		
		(CHF/ gross ton -km)	0,0030	
		Trains powered with thermal energy and running on electrified lines, except trial runs, runs with historical vehicles and service trains of infrastructure operators		
		(CHF/ per arrival or departure)	Type of node	
			Big nodes	Small nodes
		Supplements for nodes	5,00	3,00

Components of the formula *(units)*				Categories		
Charge for basic services	Contribution margin		*(CHF)*	Type of passenger traffic		
				Long – distance passenger traffic	Regional passenger traffic	
			Traffic requiring a concession	% share	% share	
			(see each category)	Type de category		
				Goods traffic		Passenger traffic
				On the network of SBB and RM	On BLS's network	
			Traffic not requiring a concession	0,0052 CHF/net ton-km	0,0035 CHF/ net ton -km	0,0027 CHF/ offer km
		Other services charged for via the contribution margin	*(CHF/km-axle)*	0,03		
			Carriage of dangerous goods[1]			
			(CHF/train)	Owner of the network		
				On BLS's network (loading code > P60 – P80)	On BLS's network (loading code less or equal to P60)	
			SIM trains	300,00	300,00	
			(CHF/train)	Line		
				Kandersteg – Goppenstein	Kanderstweg – Iselle	
			Car-carrying trains	10,00	5,00	

Components of the formula *(units)*					Categories									
Charge for basic services	Energy cost rates and standard values	Energy (from 1.7.2005)	*(Day / CHF)*	Train type	Train type									
			Daytime rate of energy		Interciity / Eurocity	Fast train / Interregio	Regional train	S-Bahn	RegioExpress	Long – distance freight trains	Local freight trains	Light rail motor tractor – hauled train	Loco – hauled train	Empty passenger stock
				SBB	0,0029	0,0029	0,0058	0,0058	0,0029	0,0027	0,0038	0,0038	0,0044	0,0044
				BLS	0,0043	0,0043	0,0062	0,0062	0,0031	0,0029	0,0041	0,0041	0,0047	0,0047
				RM	0,0031	0,0031	0,0062	0,0062	0,0031	0,0029	0,0041	0,0041	0,0047	0,0047
			Night rate of energy	**Night rate of energy** = Daytime rate of energy x Night coefficient										
				(without units)	0,64									
				Night coefficient										

Components of the formula *(units)*			Categories
Charge for basic services	Noise bonus	*(CHF/ km-axle)*	0,010
		Refund for vehicles that were made less noisy	
	Ordering train paths	*(CHF/train path)*	50,00
		Fee for the treatment of orders coming in after 16.00 hours on the day preceding operation	

SBB – Schweizerische Bundesbahnen
BLS
RM – Regionalverkehr Mittelland

SWITZERLAND

Handling fees for cancellation of definitively assigned paths	*(CHF/per day of operation and timetable period)*	Cancellation period	
		One month after definitive path allocation (before the annual timetable change)	After expiry of the "free of charge" period and until the timetable change
	Cancellation of regular-service train paths	Free of charge	2.000,00
	(CHF)	Cancellation period	
		Until 4 p.m. on the previous day	From 4.01 p.m. on the day before execution and on the day itself
	Cancellation on single days of operation per train path	50,00	100,00

Train path options	*(see each category)*	Period	
		Price (CHF) per day and timetable period	Price (CHF) per day of operation and timetable year
	Path options cancelled later than one month after their definitive allocation	4.000,00	400 Remark: only for cross-border services at Bassel and Geneva, link to path options in adjoining networks.

Charge for supplementary services	Shunting	*(CHF/movement)*	Type of vehicle	Movement on	
				SBB/RM network	BLS network
		Route – setting for shunting runs (except for trains being processed in the marshalling yards of SBB)	Shunting with electric vehicles	4,00	6,00
			Shunting with thermic vehicle	3,00	5,00
		Shunting in marshalling yards of SBB	*(CHF/vehicle)*	Movement	
				Entry	Exit
			Wagons throughput marshalling yard	5,00	5,00
			Formation yards	100,00 CHF from 2nd yard	
			Supplement for special shunting	20,00 CHF/vehicle	

(CHF/metre)	Period	On the SBB, BLS and RM network		
Stabling of railway vehicles		Big nodes including Interlaken Ost and Zweisimmen	Small nodes including Belp, Bern Bümpliz Nord, Frutigen Goppenstein, Grenchen Nord, Heustrich-Emdthal, Ins, Interlaken West, Kandersteg, Uetendorf	Other stations
	Per day	3,00	2,00	1,00
	Per month	30,00	20,00	10,00
	Per year	120,00	80,00	40,00

Provision of water and electricity	*(CHF/volume unit)*	Volume unit	
		Per m3	Per wagon
	Water	5,00	1,00
	(CHF/ energy unit)	Energy unit	
		Per KWh	Per wagon and ½ hour
	Energy at SBB and RM	0,10	9,10

Water and energy at BLS	Electrical energy ex pre-heating plant	5,00 CHF/carriage and ½ hour				
	Electrical energy ex catenary	*Unit*	Type of vehicle			
			With rail tractor	With locomotive	Lightweight emu (RBDe, Nina...)	Only loco or driving head of emu
		CHF/carriage and ½ hour	5,00	7,00	5,00	-
		CHF/ ½hour	-	-	-	5,00

Use of the line outside its hours of operation	80,00 CHF/hour and exceptional manned station
Use of track weighbridges or weighing machines for road vehicles (2)	10,00 CHF/per weighing (wagon/vehicle)

(CHF/unit)	Network	Unit		
		Per hour and fractions thereof	Per ¼ hour	Minimum
Use of the crane (2)	SBB et RM	80,00	-	-
	BLS	-	10,00	20,00

Planning and special tasks	106,00 CHF/hour and fractions thereof

Purchase of the current regulation for infrastructure use	Regulations	
	Basic equipment (CFF/BLS/RM)	Updates (CFF/BLS/RM)
	200 CHF/set	*50 CHF/ year and set*

Requested open track stops (going further than train path use)	100,00 CHF/stop

SBB CFF FFS
bls
RM Regionalverkehr Mittelland

SBB – Schweizerische Bundesbahnen
BLS
RM – Regionalverkehr Mittelland

SWITZERLAND

Charge for supplementary services	**Exceptional stops at stations**	50,00 CHF/stop	
	(CHF/15 minutes)	**Type of request**	
	(minimum charge: 1 hour)	**Processing of requests for information on train paths (timetable and price) plus 1 addition**	**As from 2nd addition**
	Timetable investigations	Free of charge	50,00 (minimum 200,00)
	Processing of urgent requests in connecting with licences, safety, certification, etc.	300,00 CHF/request Remark: Charge for requests that are to be processed within one week	
Charge for miscellaneous services	**Driving training runs on SBB, BLS and RM network**	300,00 CHF Remark: Charge per certificate for line familiarisation runs in the driver's cab and per infrastructure	
	(CHF)	**Type of service**	
		Preparation of quotes for feasibility studies on entire timetable systems/operating concepts, etc.	**Other services**
	Feasibility studies	Price on request	Price on request
	Shunting with locomotive and staff	Price on request	
	Coupling/uncoupling of locomotives	Price on request	
	Removal/mounting of tail lights	Price on request	
	(CHF)	**Type of brake test**	
		With locomotive/braking system	**Additional brake test**
	Brake test (by written agreement only)	Price on request	Price on request
	Message to drivers	Price on request	

Source: Sánchez-Borràs from List of Infrastructure Services 2006
(Prices valid from 11.12.05 to 09.12.06)

(1) This price type will not be used between 11.12.2005 and 9.12.2006.
(2) The prices do not include cooperation of the infrastructure operator.

Eurotunnel

UNITED KINGDOM/
FRANCE

FORMULA :

Charge for passenger trains = Deduced from the contract between Eurotunnel and Eurostar

Charge for freight trains = (Reservation fee) + (Running charge) + (Administrative costs) + + (Additional services)

Components of the formula *(unit)*				Categories				
Passenger trains			*(€/train)* Eurostar	**15.890**				
Freight trains	**Fee for the minimum access package**	**Reservation fee**	*(€/year)*	**Train Speed (km/h)**	**Period**			
					Off-peak period	**Intermediate period**	**Peak Period**	**Maintenance period**
			Offer 1	**140**	39.312	49.140	58.968	-
				120	52.285	65.356	78.427	-
				100	73.710	147.420	221.130	163.800(1)
			(€/train)	**Train Speed (km/h)**	**Period**			
					Off-peak period	**Intermediate period**	**Peak Period**	**Maintenance period**
			Offer 2	**140**	847	1.058	1.270	-
				120	1.126	1.408	1.689	-
				100	1.588	3.175	4.763	3.528(1)
			Offer 3	2.363 *€/train* (2)				
		Running charge	*(€/train)*	**Train Speed (km/h)**	**Period**			
					Off-peak period	**Intermediate period**	**Peak Period**	**Maintenance period**
			Offer 1	**140**	1.764	2.205	2.646	-
				120	2.346	2.933	3.519	-
				100	3.308	6.615	9.923	7.350(1)
			(€/train)	**Train Speed (km/h)**	**Period**			
					Off-peak period	**Intermediate period**	**Peak Period**	**Maintenance period**
			Offer 2	**140**	1.976	2.470	2.964	-
				120	2.628	3.285	3.941	-
				100	3.704	7.409	11.113	8.232(1)
			Offer 3	The running charge for the offer 3 is included in the reservation fee of offer 3				
		Adminis-tration costs	**Offer 1**	Without administration costs				
			Offer 2 (3)	7.500 €/contract				
			Offer 3 (3)	7.500 €/contract				
	Additio-nal services	**Fee for shunting service**		7.500 €/shunted train				
		Fee for abnormal loads						

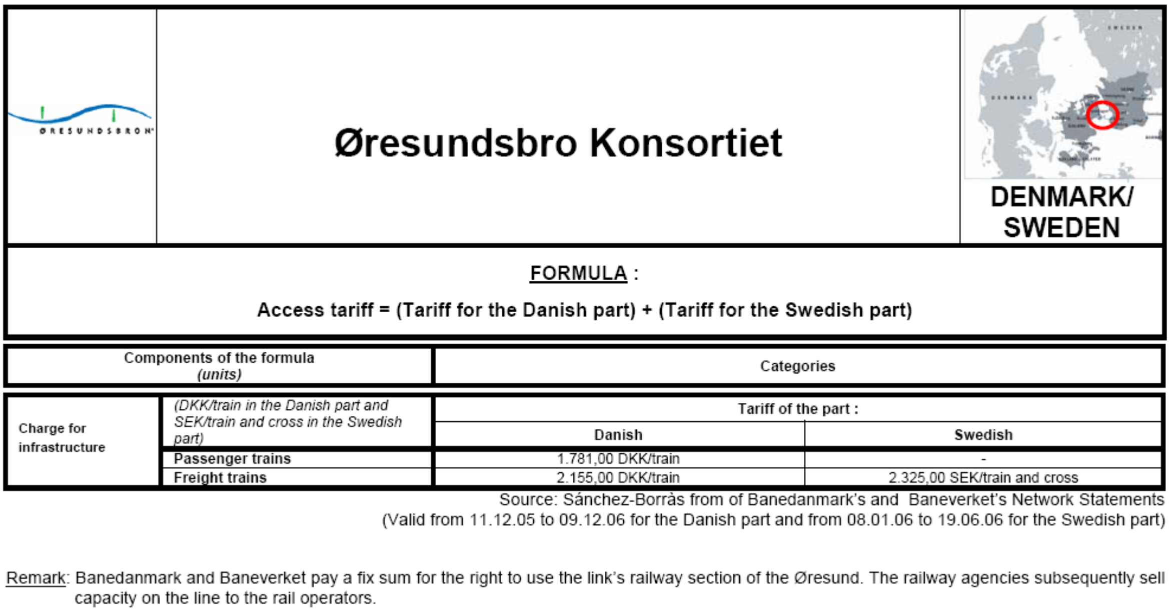
Source: Sánchez-Borràs from the Eurotunnel's Network Statement (2004 timetable)
(Prices valid from 14.12.2003 to 11.12.2004)

(1) Only a speed of 100 Km/h is permitted during the maintenance period.
(2) It includes the reservation fee plus the running charge.
(3) The contract may be combined with the contract for Offer 3 / 2 so as to make a single contract. In this case, the administration costs are not added together.

Remark: The equivalent price per train (based on 52 trains/year) of the total charge is the following one:

Equivalent price per train (based on 52 trains/year)

	Type of offer *(unit)*	Price				
Reservation fee + Running charge	*(€/train)*	**Train Speed (km/h)**				
			Off-peak period	**Intermediate period**	**Peak Period**	**Maintenance period**
	Offer 1	**140**	2.520	3.150	3.780	-
		120	3.352	4.190	5.027	-
		100	4.725	9.450	14.175	10.500
	(€/train)	**Train Speed (km/h)**				
			Off-peak period	**Intermediate period**	**Peak Period**	**Maintenance period**
	Offer 2	**140**	2.822	3.528	4.234	-
		120	3.754	4.692	5.631	-
		100	5.292	10.584	15.876	11.760



Øresundsbro Konsortiet

**DENMARK/
SWEDEN**

FORMULA :

Access tariff = (Tariff for the Danish part) + (Tariff for the Swedish part)

Components of the formula *(units)*		Categories	
		Tariff of the part :	
Charge for infrastructure	*(DKK/train in the Danish part and SEK/train and cross in the Swedish part)*	**Danish**	**Swedish**
	Passenger trains	1.781,00 DKK/train	-
	Freight trains	2.155,00 DKK/train	2.325,00 SEK/train and cross

Source: Sánchez-Borràs from of Banedanmark's and Baneverket's Network Statements
(Valid from 11.12.05 to 09.12.06 for the Danish part and from 08.01.06 to 19.06.06 for the Swedish part)

Remark: Banedanmark and Baneverket pay a fix sum for the right to use the link's railway section of the Øresund. The railway agencies subsequently sell capacity on the line to the rail operators.

ANNEX A4

RATES OF EXCHANGE

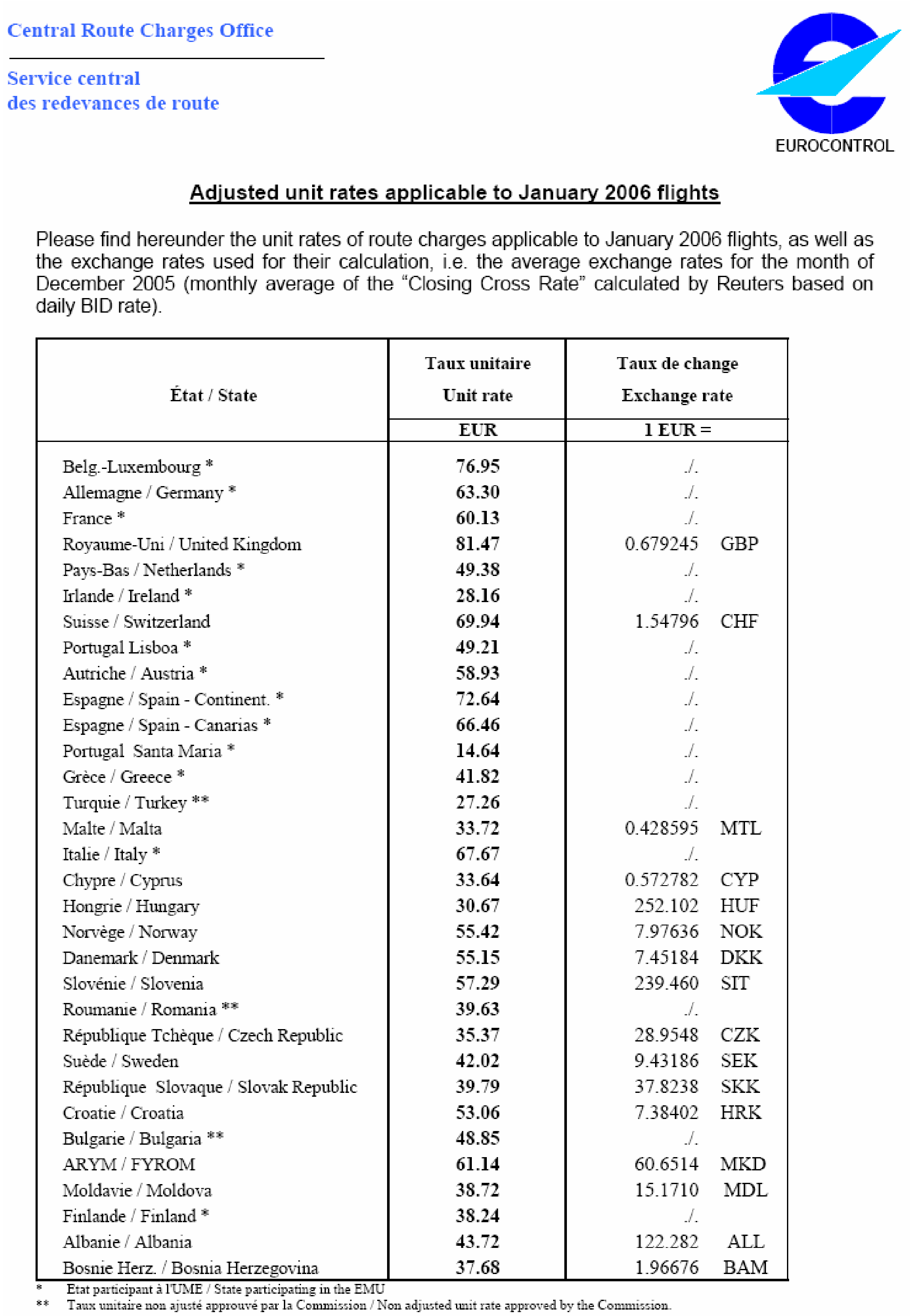
The rates of exchange used in this study for comparing the amounts of rail infrastructure charges are the ones provided by the European Central Bank (ECB), valid on January 16, 2006 (see **table A4.1**).

TABLA A4. 1 RATES OF EXCHANGE VALID IN JANUARY 16, 2006
Source: ECB (2006)

Currency name	Abbreviation	1€ =
Czech koruna	CZK	28,80
Danish krone	DKK	7,46
Estonian kroon	EEK	15,65
Pound sterling	GBP	0,69
Hungarian florint	HUF	250,32
Lithuanian litas	LTL	3,45
Latvian lats	LVL	0,70
Polish złoty	PLN	3,81
Swedish krona	SEK	9,33
Slovenian dolar	SIT	239,51
Slovak koruna	SKK	37,48
Swiss franc	CHF	1,55
Norwegian krone	NOK	8,05

ANNEX A5

ADJUSTED UNIT RATES APPLICABLE TO JANUARY 2006 FLIGHTS



Central Route Charges Office

Service central
des redevances de route

EUROCONTROL

Adjusted unit rates applicable to January 2006 flights

Please find hereunder the unit rates of route charges applicable to January 2006 flights, as well as the exchange rates used for their calculation, i.e. the average exchange rates for the month of December 2005 (monthly average of the "Closing Cross Rate" calculated by Reuters based on daily BID rate).

État / State	Taux unitaire Unit rate	Taux de change Exchange rate	
	EUR	1 EUR =	
Belg.-Luxembourg *	76.95	./.	
Allemagne / Germany *	63.30	./.	
France *	60.13	./.	
Royaume-Uni / United Kingdom	81.47	0.679245	GBP
Pays-Bas / Netherlands *	49.38	./.	
Irlande / Ireland *	28.16	./.	
Suisse / Switzerland	69.94	1.54796	CHF
Portugal Lisboa *	49.21	./.	
Autriche / Austria *	58.93	./.	
Espagne / Spain - Continent. *	72.64	./.	
Espagne / Spain - Canarias *	66.46	./.	
Portugal Santa Maria *	14.64	./.	
Grèce / Greece *	41.82	./.	
Turquie / Turkey **	27.26	./.	
Malte / Malta	33.72	0.428595	MTL
Italie / Italy *	67.67	./.	
Chypre / Cyprus	33.64	0.572782	CYP
Hongrie / Hungary	30.67	252.102	HUF
Norvège / Norway	55.42	7.97636	NOK
Danemark / Denmark	55.15	7.45184	DKK
Slovénie / Slovenia	57.29	239.460	SIT
Roumanie / Romania **	39.63	./.	
République Tchèque / Czech Republic	35.37	28.9548	CZK
Suède / Sweden	42.02	9.43186	SEK
République Slovaque / Slovak Republic	39.79	37.8238	SKK
Croatie / Croatia	53.06	7.38402	HRK
Bulgarie / Bulgaria **	48.85	./.	
ARYM / FYROM	61.14	60.6514	MKD
Moldavie / Moldova	38.72	15.1710	MDL
Finlande / Finland *	38.24	./.	
Albanie / Albania	43.72	122.282	ALL
Bosnie Herz. / Bosnia Herzegovina	37.68	1.96676	BAM

* Etat participant à l'UME / State participating in the EMU

** Taux unitaire non ajusté approuvé par la Commission / Non adjusted unit rate approved by the Commission.

ANNEX A6

OUTPUTS FROM THE CALCULATIONS OF INFRASTRUCTURE CHARGES AND REVENUES

In **table A.6.1** are presented the results from the calculations of infrastructure charges and revenues done with the methodology and assumptions presented in chapter 3.

TABLE A.6.1 OUTPUTS FROM THE CALCULATIONS OF INFRASTRUCTURE CHARGES AND REVENUES

Link	Railways				Airways			
	IC (€)	Rev (€)	IC/Rev	Rev-IC	IC (€)	Rev (€)	IC/Rev	Rev-IC
1.Frankfurt – Köln	2.184,28	13.406,30	16,29%	11.222,02	-	-	-	-
2.Wien – Salzburg	803,40	10.432,50	7,70%	9.629,10	-	-	-	-
3.Bruxelles – Liège	1.083,15	3.022,50	35,84%	1.939,35	-	-	-	-
4.København – Esbjerg	839,79	9.702,57	8,66%	8.862,78	-	-	-	-
5.Bratislava – Zilina	310,68	1.743,07	17,82%	1.432,39	-	-	-	-
6.Ljubljana – Maribor	417,45	3.012,75	13,86%	2.595,30	-	-	-	-
7.Madrid – Sevilla	4.798,47	17.013,75	28,20%	12.215,28	2.344,24	17.419,50	13,46%	15.075,26
8.Tallin – Narva	781,73	1324,17	59,04%	542,44	-	-	-	-
9.Helsinki – Turku	110,85	5.703,75	1,94%	5.592,90	4.071,45	10.830,23	37,59%	6.758,78
10.Paris – Lyon	6.302,84	14.308,13	44,05%	8.005,29	3.795,06	12.950,18	29,31%	9.155,12
11.Athinai – Thessaloniki	-	8.11,88	-	-	2.828,62	11.333,75	24,96%	8.505,13
12.Amsterdam – Breda	230,46	4.387,50	5,25%	4.157,04	-	-	-	-
13.Budapest – Debrecen	605,30	2.298,06	26,34%	1.692,76	-	-	-	-
14.Belfast – Dublin	-	8.409,38	-	-	-	-	-	-
15.Roma – Firenze	989,13	7.176,00	13,78%	6.186,87	5.218,09	11.251,28	46,38%	6.033,19
16.Riga – Recekne	746,77	833,63	89,58%	86,86	-	-	-	-
17.Vilnius – Klaipeda	1.090,40	2.760,26	39,50%	1.669,86	-	-	-	-
18.Belgian border – Kleinbettingen – Luxembourg – Bettembourg – French border	238,70	1.218,75	19,59%	980,05	-	-	-	-

Link	**Railways**				**Airways**			
	IC (€)	**Rev (€)**	**IC/Rev**	**Rev-IC**	**IC (€)**	**Rev (€)**	**IC/Rev**	**Rev-IC**
19.Oslo – Trondheim	0,00	24.135,76	0,00%	24.135,76	2.774,96	14.647,50	18,94%	11.872,54
20.Warszawa – Katowice	776,65	5.694,94	13,64%	4.918,29	2.151,49	6.644,40	32,38%	4.492,91
21.Lisboa – Porto	471,80	5.728,13	8,24%	5.256,33	2.298,93	13.064,10	17,60%	10.765,17
22.London –Newcastle	4.054,17	37.516,41	10,81%	33.462,24	4.202,46	21.193,20	19,83%	16.990,74
23.Praha – Brno	284,21	1.531,90	18,55%	1.247,69	-	-	-	-
24.Göteborg – Stockholm	277,16	28.818,48	0,96%	28.541,32	3.838,74	6.741,00	56,95%	2.902,26
25.Genève – Lausanne – Bern – Zürich	521,13	12.111,22	4,30%	11.590,09	2.503,23	9.301,43	26,91%	6.798,20
26. København – Malmö	242,96	-	-	-	-	-	-	-
27. Madrid – Toledo	1.071,00	2.023,13	52,94%	952,13	-	-	-	-
28. Bratislava – Wien	180,23	-	-	-	-	-	-	-
29. Lille – Bruxelles	1.157,74	5.850,00	19,79%	4.692,26	-	-	-	-
30. Warszawa – Lódz	321,70	1.815,98	17,71%	1.494,28	-	-	-	-
31. Manchester - Birmingham	1.809,66	7.823,34	23,13%	6.013,68	-	-	-	-
32. Praha – Ostrawa	347,39	3.385,89	10,26%	3.038,50	-	-	-	-
33. Ljubljana – Trieste	447,52	3.656,25	12,24%	3.208,73	-	-	-	-
34. Milano – Genova	726,81	3.997,50	18,18%	3.270,69	-	-	-	-
35. Lyon – Genève	568,91	9.579,38	5,94%	9.010,47	-	-	-	-
36. Strasbourg – Stuttgart	762,60	8.263,13	9,23%	7.500,53	-	-	-	-
37. Paris – Tours	2.618,37	9.165,00	28,57%	6.546,63	-	-	-	-
38. Paris – Lille	3.405,86	8.848,13	38,49%	5.442,27	-	-	-	-
39. Roma – Napoli	1.051,10	5.079,75	20,69%	4.028,65	-	-	-	-
40. Amsterdam – Bruxelles	958,81	10.725,00	8,94%	9.766,19	-	-	-	-
41. Hannover – Berlin	1.332,35	12.918,75	10,31%	11.586,40	-	-	-	-
42. Wien – Nürnberg	1.571,80	18.086,25	8,69%	16.514,45	4.925,72	7.811,48	63,06%	2.885,76
43.Warszawa – Poznań	1.104,02	5.694,94	19,39%	4.590,92	2.133,78	5.692,05	37,49%	3.558,27
44. Madrid – Zaragoza	2.854,61	10.286,25	27,75%	7.431,64	-	-	-	-
45. Firenze – Milano	1.122,10	7.049,25	15,92%	5.927,15	5.356,78	11.707,50	45,76%	6.350,72
46. Lyon – Marseille	2.646,53	10.505,63	25,19%	7.859,10	3.350,37	14.905,28	22,48%	11.554,91
47. Warszawa – Gdańsk	786,28	5.758,93	13,65%	4.972,65	2.087,67	4.961,78	42,08%	2.874,11
48. Hannover – Frankfurt	1.895,95	17.306,25	10,96%	15.410,30	4.854,30	11.923,80	40,71%	7.069,50

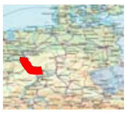
Link	**Railways**				**Airways**			
	IC (€)	**Rev (€)**	**IC/Rev**	**Rev-IC**	**IC (€)**	**Rev (€)**	**IC/Rev**	**Rev-IC**
49. Bruxelles – Köln	875,87	9.750,00	8,98%	8.874,13	-	-	-	-
50. Paris – Rennes	2.760,64	12.236,25	22,56%	9.475,61	3.744,42	21.788,03	17,19%	18.043,61
51. London – Bruxelles	18.430,14	54.478,13	33,83%	36.047,99	4.773,51	30.858,45	15,47%	26.084,94
52. Warszawa – Wrocław	800,33	2.459,70	32,54%	1.659,37	2.848,30	16.056,60	17,74%	13.208,30
53. Praha – Berlin	1.077,88	13.113,75	8,22%	12.035,87	3.918,90	45.014,03	8,71%	41.095,13
54. Bratislava – Košice	699,34	3.369,07	20,76%	2.669,73	-	-	-	-
55. Praha – Wien	517,33	-	-	-	4.544,78	23.352,00	19,46%	18.807,22
56. Amsterdam – Berlin	2.432,65	23.692,50	10,27%	21.259,85	5.861,85	28.436,63	20,61%	22.574,78
57. Paris – Strasbourg	1.535,52	11.261,25	13,64%	9.725,73	3.694,40	14.534,10	25,42%	10.839,70
58. Paris – Amsterdam	4.211,09	23.765,63	17,72%	19.554,54	4.737,99	36.830,33	12,86%	32.092,34
59. Paris – Genève	5.527,86	16.818,75	32,87%	11.290,89	4.402,26	18.338,78	24,01%	13.936,52
60. Warszawa – Berlin	2.178,86	9.506,25	22,92%	7.327,39	4.439,77	35.503,13	12,51%	31.063,36
61. Paris – Bordeaux	3.417,43	15.526,88	22,01%	12.109,45	3.795,46	19.598,78	19,37%	15.803,32
62. Praha – München	2.202,65	18.963,75	11,62%	16.761,10	4.003,67	40.675,43	9,84%	36.671,76
63. Stockholm – Oslo	262,00	16.773,77	1,56%	16.511,77	2.117,15	15.292,20	13,84%	13.175,05
64. Madrid – Barcelona	4.594,91	15.356,25	29,92%	10.761,34	2.427,69	5.187,00	46,80%	2.759,31
65. London –Edinburgh	4.821,39	39.472,24	12,21%	34.650,85	4.424,08	19.982,03	22,14%	15.557,95
66. Lisboa – Madrid	772,67	13.528,13	5,71%	12.755,46	3.877,51	30.754,50	12,61%	26.876,99
67. Barcelona – Bordeaux	1.548,88	15.136,88	10,23%	13.588,00	-	-	-	-
68. Barcelona – Lyon	2.273,20	16.453,13	13,82%	14.179,93	3.720,29	39.256,88	9,48%	35.536,59
69. Oslo – København	536,50	22.025,37	2,44%	21.488,87	2.382,89	19.059,60	12,50%	16.676,71
70. Warszawa – Wien	1.374,91	-	-	-	4.672,72	38.411,10	12,17%	33.738,38
71. Paris – Marseille	7.686,59	18.330,00	41,93%	10.643,41	3.736,79	20.310,68	18,40%	16.573,89
72. Paris – Hannover	5.677,24	33.759,38	16,82%	28.082,14	4.590,55	44.497,95	10,32%	39.907,40
73 København – Köln	2.418,40	29.932,50	8,08%	27.514,10	-	-	-	-
74. Strasbourg – Nürnberg	1.146,17	15.819,38	7,25%	14.673,21	-	-	-	-
75. Milano – Köln	3.127,15	36.806,25	8,50%	33.679,10	-	-	-	-
76. London – Strasbourg	18.864,00	56.671,88	33,29%	37.807,88	-	-	-	-
77. München – Roma	2.476,63	29.932,50	8,27%	27.455,87	-	-	-	-
78. Hamburg – Stockholm	1.222,48	46.868,09	2,61%	45.645,61	-	-	-	-
79. Amsterdam – Warszawa	4.587,32	33.198,75	13,82%	28.611,43	5.364,49	35.715,23	15,02%	30.350,74

Link	Railways				Airways			
	IC (€)	Rev (€)	IC/Rev	Rev-IC	IC (€)	Rev (€)	IC/Rev	Rev-IC
80. London – Bordeaux	22.976,14	58.500,00	39,28%	35.523,86	-	-	-	-
81. Genève – Wien	2.437,57	46.653,75	5,22%	44.216,18	4.852,04	36.766,28	13,20%	31.914,24
82. Barcelona – Sevilla	7.912,18	20.182,50	39,20%	12.270,32	2.604,46	9.754,50	26,70%	7.150,04
83. Barcelona – Paris	3.388,57	38.268,75	8,85%	34.880,18	3.929,30	36.389,85	10,80%	32.460,55
84. Hamburg – Wien	4.830,53	37.342,50	12,94%	32.511,97	4.764,63	7.773,15	61,30%	3.008,52
85. Lisboa – Barcelona	3.940,83	28.884,38	13,64%	24.943,55	5.508,59	36.529,50	15,08%	31.020,91
86. Marseille – Amsterdam	11.243,56	42.095,63	26,71%	30.852,07	-	-	-	-
87. Praha – Paris	4.344,24	37.147,50	11,69%	32.803,26	4.479,20	47.416,43	9,45%	42.937,23
88. Paris – Wien	4.557,44	41.803,125	10,90%	37.245,69	5.393,21	23.248,05	23,20%	17.854,84
89. Luxembourg – Warszawa	6.330,75	39.243,75	16,13%	32.913,00	-	-	-	-
90. Paris – Roma	8.731,20	31.987,50	27,30%	23.256,30	4.409,93	63.653,63	6,93%	59.243,70
91. Glasgow – Rennes	27.896,32	88.140,00	31,65%	60.243,68	-	-	-	-
92. Paris – Warszawa	9.095,91	57.037,50	15,95%	47.941,59	5.149,10	41.411,48	12,43%	36.262,38
93. Zürich – Warszawa	3.635,40	42.363,75	8,58%	38.728,35	5.347,16	32.701,73	16,35%	27.354,57
94. Madrid – Zürich	6.715,57	52.650,00	12,76%	45.934,43	5.238,15	45.543,23	11,50%	40.305,08
95. München – Stockholm	5.257,71	66.368,09	7,92%	61.110,38	5.197,34	79.058,18	6,57%	73.860,84
96. Madrid – Bruxelles	5.059,47	57.159,38	8,85%	52.099,91	5.359,28	78.828,75	6,80%	73.469,47
97. London – Warszawa	23.128,60	94.209,38	24,55%	71.080,78	5.000,36	21.615,83	23,13%	16.615,47
98. Barcelona – Wien	4.743,63	83.947,50	5,65%	79.203,87	4.945,84	40.367,25	12,25%	35.421,41
99. Lisboa – Genève	5.747,42	66.178,13	8,68%	60.430,71	-	-	-	-
100. Madrid – Wien	7.334,25	99.303,75	7,39%	91.969,50	5.922,56	46.089,75	12,85%	40.167,19

ANNEX A7

RAIL INFRASTRUCTURE CHARGES CALCULATIONS FOR SELECTED LINKS

Frankfurt – Köln



COUNTRY	DE (Frankfurt - Köln)
IM	DB

FORMULA APPLIED :

(1) DB : Price*(train-path km) = (Base price) x (Product factor) x (Special factors) x (Regional factor) + (Stops at stations)

* Additive special factors are not applicable to this calculation (value equal to 0)

OD SEGMENTATION:

Country	**IM**	**Segment**				**Charging category**	**Usage category**	**D (km)**	**Speed (km/h)**
		N°	**Code**	**Points**					
				Departure	**Arrival**				
DE	DB Netz	3603	DE-3603	Frankfurt (Main) Hbf	Frankfurt (Main) Gutleuthof	F3	2	2,158	90
DE	DB Netz	3620	DE-3620	Frankfurt (Main) Gutleuthof	Frankfurt-Niederrad	F3	2	2,199	90
DE	DB Netz	3520	DE-3520	Frankfurt-Niederrad	Frankfurt (Main) Sportfeld	F3	1	1,817	130
DE	DB Netz	2690	DE-2690	Frankfurt (Main) Sportfeld	Frankfurt(M) Flughafen Fernbahnhof	FP	2	5,377	300
DE	DB Netz	2690	DE-2690	Frankfurt(M) Flughafen Fernbahnhof	Lumburg (Lahn) Süd	FP	2	58,762	300
DE	DB Netz	2690	DE-2690	Lumburg (Lahn) Süd	Lumburg (Lahn) Süd HE/RP	FP	2	7,194	300
DE	DB Netz	2690	DE-2690	Lumburg (Lahn) Süd HE/RP	Willroth	FP	2	41,385	300
DE	DB Netz	2690	DE-2690	Willroth	Windhagen NRW/RP	FP	2	15,724	300
DE	DB Netz	2690	DE-2690	Windhagen NRW/RP	Siegburg/Bonn	FP	2	20,211	300
DE	DB Netz	2651	DE-2651	Siegburg/Bonn	Troisdorf	F6	2	4,305	200
DE	DB Netz	2651	DE-2651	Troisdorf	Köln Steinstraße (Abzw)	F6	2	11,880	200
DE	DB Netz	2651	DE-2651	Köln Steinstraße (Abzw)	Vingst	F3	2	3,869	160
DE	DB Netz	2651	DE-2651	Vingst	Köln-Kalk	F3	2	1,727	160
DE	DB Netz	2651	DE-2651	Köln-Kalk	Köln-Deutz	F3	2	2,200	120
DE	DB Netz	2639	DE-2639	Köln-Deutz	Köln Hbf	F3	2	1,200	80

DEFINITION OF THE VARIABLES:

DB Netz	- Type of train-path: Long distance regular interval path - Load factor: Not applicable ⟹ Value equal to 1 - Train without titling technology - Regional factors: Not applicable ⟹ Value equal to 1

RESULTS OF THE RAIL INFRASTRUCTURE CHARGE CALCULATION:

Link	**Country**	**IM**	**Infrastructure charge**			
Frankfurt - Köln	DE	DB Netz	Train-path charge (€)	Charge for stops at stations (€)	**Total**	
					€	**€/train-km**
			2.148,7	35,5	2.184,3	12,1

Wien – Salzburg

COUNTRY	AT (Wien - Salzburg)
IM	ÖBB

FORMULA APPLIED :

(1) ÖBB : Infrastructure charge* = (Charge for train movement) + (Charge for stops at stations)

* Charges for shunting, parking, for the use of other facilities and for other services not taken into account in the calculation.

OD SEGMENTATION:

		Segment					
				Points			
Country	**IM**	**N°**	**Code**	**Departure**	**Arrival**	**Charging category**	**D (km)**
AT	ÖBB	1	AT-1	Wien Estbahnhof	Staatsgrenze N. Salzburg	Westbahn	317

DEFINITION OF THE VARIABLES:

ÖBB	- Train's weight: 430 tonnes - Market segment: Passenger traffic - Traction unit category: Category A - Station category : • Wien Estbahnhof : Category 1 • Staatsgrenze N. Salzburg : Category 1 - Hypothesis : • Without bottlenecks • Optimal performance regime : 0 minutes of delay

RESULTS OF THE RAIL INFRASTRUCTURE CHARGE CALCULATION:

Link	**Country**	**IM**	**Infrastructure charge**					
			Charge for train movement			Charge for stops at stations	**Total**	
			Standard package **(€)**	Mark ups and discounts **(€)**	**Total (€)**	Standard package (€)	**€**	**€/train-km**
Wien - Salzburg	AT	ÖBB	805,18	-12,68	792,5	10,9	803,4	2,5

Bruxelles - Liège

COUNTRY	BE (Bruxelles – Liège)
IM	Infrabel

FORMULA APPLIED :

(2) INFRABEL : Rail infrastructure charge* = (Charge train path-line) + (Charge train path-facility)

* Shunting charge and administrative fees not considered in the calculation.

OD SEGMENTATION:

Country	IM	Segment N°	Segment Code	Points Departure	Points Arrival	Charging category: Running priority category	Admissible weight on rail category	Line category: For coefficient C1(i)	Line category: For coefficient C2(i)	Category H > (1) 8h	Category H > (1) 18h	Category H < (2) 8h	Category H < (2) 18h	Station category	D (km)	Speed (km/h)
BE	Infrabel	0/1	BE-0/1	Bruxelles-Midi	Bruxelles Nord	1	2	1	2	1	1	1	1	Terminal TGV Bruxelles – Midi sillon TGV	3,6	220
BE	Infrabel	36	BE-36	Bruxelles Nord	Shaerbeek	1	2	1	3	2	2	2	2	- (4)	2,5	220
BE	Infrabel	36	BE-36	Shaerbeek	Y. Zaventen	1	2	1	3	1	1	1	1	- (4)	7,9	220
BE	Infrabel	36	BE-36	Y. Zaventen	Leuven	1	2	1	3	3	1	1	3	- (4)	18,4	220
BE	Infrabel	36	BE-36	Leuven	Landen	1	2	1	3	3	2	2	3	- (4)	31,9	220
BE	Infrabel	36	BE-36	Landen	Liège-Guillemins	1	2	1	3	3(3)	3	3	3(3)	1	38,6	220

(1) > : running direction start – end (Bruxelles – Liège).
(2) < : running direction end – start (Liège – Bruxelles).
(3) Without information in the Network Statement.
(4) Intermediate stops not considered according to the calculations hypothesis.

DEFINITION OF THE VARIABLES:

Infrabel	- Difference compared to the standard train-path : From 0,00% to 5% - Time at a station: 30 minutes - Time period : Departure at 8h00 and comeback at 18h00 (applicable to Category H). Both running directions considered.

RESULTS OF THE RAIL INFRASTRUCTURE CHARGE CALCULATION:

Link	Country	IM	Running direction		Infrastructure charge: Charge train-path line	Charge train-path facility	Total charge €	Average	€/tr-km	Average
Bruxelles-Liège	BE	Infrabel	Bruxelles -Liège	Departure at 8h	302,2	785,4	1087,6	1201,5	10,6	11,7
				Departure at 18h	538,9	785,4	1324,3		12,9	
			Liège-Bruxelles	Departure at 8h	538,9	776,4	1315,3		12,8	
				Departure at 18h	302,2	776,4	1078,6		10,5	

Paris – Hannover

COUNTRY	FR	BE	DE	
	Paris	Wannehain (border) - Esplechin (border)	Hergenrath (border) - Aachen Süd Grenze	Hannover
IM	RÉSEAU FERRÉ DE FRANCE	Infrabel	DB	

FORMULA APPLIED :

(1) RFF : Access charge$^{(i)}$ = (Charges for minimum services) + (Charge for access to facilities)

(2) INFRABEL : Rail infrastructure charge $^{(ii)}$ = (Charge train path-line) + (Charge train path-facility)

(3) DB : Price$^{(iii)}$(train-path km) = (Base price) x (Product factor) x (Special factors) x (Regional factor) + (Stops at stations)

(i) Charges for additional services not considered in the calculations.
(ii) Shunting charge and administrative fees not considered in the calculation.
(iii) Additive special factors are not applicable to this calculation (value equal to 0).

OD SEGMENTATION:

Country	IM	Segment		Points		Charging category	Usage category	D (km)
		N°	Code	Departure	Arrival			
FR	RFF	21002	FR-21002	Paris (Nord)	St. Denis	A		6,1
FR	RFF	21003	FR-21003	St. Denis	Pierrefitte Stains	A		4,6
FR	RFF	21004	FR-21004	Pierrefitte Stains	Villiers-le-Bel-Gonesse	A		4,1
FR	RFF	23001	FR-23001	Villiers-le-Bel-Gonesse	Vémars	N1		14,4
FR	RFF	23002	FR-23002	Vémars	Croisilles	N1		134,4
FR	RFF	23003	FR-23003	Croisilles	Sainghin	N1		49,1
FR	RFF	23018	FR-23005	Sainghin	Wannehain Frontière - Esplechin Frontière	N2		11,8
BE	Infrabel	1	BE-1	Wannehain Frontière - Esplechin Frontière	Y. Antoing	C1=1, C2=1		13,4
BE	Infrabel	1	BE-1	Y. Antoing	Tourpes	C1=1, C2=1		12,3
BE	Infrabel	1	BE-1	Tourpes	Y. Patard	C1=1, C2=1		18,0
BE	Infrabel	1	BE-1	Y. Patard	Y. Beauregard	C1=1, C2=1		3,5
BE	Infrabel	1	BE-1	Y. Beauregard	Halle-Ring	C1=1, C2=1		26,3
BE	Infrabel	1	BE-1	Halle-Ring	Halle	C1=1, C2=1		1,3
BE	Infrabel	1	BE-1	Halle	Y. Noord Halle	C1=1, C2=1		1,3
BE	Infrabel	96N	BE-96N	Y. Noord Halle	Y. Ruisbroek	C1=1, C2=2		7,1
BE	Infrabel	96N	BE-96N	Y. Ruisbroek	Bruxelles-Midi	C1=1, C2=2		4,9
BE	Infrabel	0	BE-0	Bruxelles-Midi	Bruxelles-Midi-Gril JNM	C1=1, C2=2		0,6
BE	Infrabel	0	BE-0	Bruxelles-Midi-Gril JNM	Bruxelles-Chapelle	C1=1, C2=2		0,4
BE	Infrabel	0	BE-0	Bruxelles-Chapelle	Bruxelles-Central	C1=1, C2=2		0,7
BE	Infrabel	0	BE-0	Bruxelles-Central	Bruxelles-Congres	C1=1, C2=2		0,9
BE	Infrabel	0	BE-0	Bruxelles-Congres	Bruxelles-Nord	C1=1, C2=2		1,0
BE	Infrabel	36	BE-36	Bruxelles-Nord	Bruxelles-Nord-Gril F	C1=1, C2=3		1,0
BE	Infrabel	36	BE-36	Bruxelles-Nord-Gril F	Schaerbeek	C1=1, C2=3		1,5
BE	Infrabel	36	BE-36	Schaerbeek	Haren-Sud	C1=1, C2=3		2,9
BE	Infrabel	36	BE-36	Haren-Sud	Y. Diegem-West	C1=1, C2=3		1,0
BE	Infrabel	36	BE-36	Y. Diegem-West	Y. Diegem-Oost	C1=1, C2=3		0,3
BE	Infrabel	36	BE-36	Y. Diegem-Oost	Diegem	C1=1, C2=3		0,6
BE	Infrabel	36	BE-36	Diegem	Zaventem Rooster P/Q	C1=1, C2=3		1,8
BE	Infrabel	36	BE-36	Zaventem Rooster P/Q	Zaventem	C1=1, C2=3		0,4
BE	Infrabel	36	BE-36	Zaventem	Y. Zaventem	C1=1, C2=3		0,9
BE	Infrabel	36	BE-36	Y. Zaventem	Nossegem	C1=1, C2=3		1,6
BE	Infrabel	36	BE-36	Nossegem	Kortenberg	C1=1, C2=3		2,7
BE	Infrabel	36	BE-36	Kortenberg	ERPS-Kwerps	C1=1, C2=3		3,1
BE	Infrabel	36	BE-36	ERPS-Kwerps	Veltem	C1=1, C2=3		3,3
BE	Infrabel	36	BE-36	Veltem	Y. Herent	C1=1, C2=3		2,3
BE	Infrabel	36	BE-36	Y. Herent	Herent	C1=1, C2=3		0,8
BE	Infrabel	36	BE-36	Herent	Y.Wilsele	C1=1, C2=3		1,9
BE	Infrabel	36	BE-36	Y.Wilsele	Leuven-Bundel M	C1=1, C2=3		1,5
BE	Infrabel	36	BE-36	Leuven-Bundel M	Leuven	C1=1, C2=3		1,2
BE	Infrabel	36	BE-36	Leuven	Y. Molenbeek	C1=1, C2=3		2,5
BE	Infrabel	36	BE-36	Y. Molenbeek	Vertrijk	C1=1, C2=3		8,7
BE	Infrabel	36	BE-36	Vertrijk	Tienen	C1=1, C2=3		7,4
BE	Infrabel	36	BE-36	Tienen	Ezemaal	C1=1, C2=3		6,4
BE	Infrabel	36	BE-36	Ezemaal	Neerwinden	C1=1, C2=3		3,0
BE	Infrabel	36	BE-36	Neerwinden	Landen	C1=1, C2=3		3,9
BE	Infrabel	36	BE-36	Landen	Waremme	C1=1, C2=3		13,8
BE	Infrabel	36	BE-36	Waremme	Bleret	C1=1, C2=3		2,7
BE	Infrabel	36	BE-36	Bleret	Remicourt	C1=1, C2=3		2,6
BE	Infrabel	36	BE-36	Remicourt	Momalle	C1=1, C2=3		3,5
BE	Infrabel	36	BE-36	Momalle	Fexhe-Le-Haut-Clocher	C1=1, C2=3		2,2
BE	Infrabel	36	BE-36	Fexhe-Le-Haut-Clocher	Voroux-Base Travaux LGV	C1=1, C2=3		1,9
BE	Infrabel	36	BE-36	Voroux-Base Travaux LGV	Voroux	C1=1, C2=3		0,4

Paris – Hannover

COUNTRY	FR	BE	DE	
	Paris	Wannehain (border) - Esplechin (border)	Hergenrath (border) - Aachen Süd Grenze	Hannover
IM	RESEAU FERRE DE FRANCE	Infrabel	DB	

Country	IM	Segment				Charging category	Usage category	D (km)
				Points				
		N°	Code	Departure	Arrival			
BE	Infrabel	36	BE-36	Voroux	Y. Voroux	C1=1, C2=3		1,3
BE	Infrabel	36	BE-36	Y. Voroux	Bierset-Awans	C1=1, C2=3		0,7
BE	Infrabel	36	BE-36	Bierset-Awans	Racc. Bierset-Zone Fret	C1=1, C2=3		0,3
BE	Infrabel	36	BE-36	Racc. Bierset-Zone Fret	Ans	C1=1, C2=3		3,3
BE	Infrabel	36	BE-36	Ans	Liège-Guillemins	C1=1, C2=3		5,9
BE	Infrabel	37	BE-37	Liège-Guillemins	Y. Val-Benoit	C1=2, C2=4		1,5
BE	Infrabel	37	BE-37	Y. Val-Benoit	Y. Aguesses	C1=2, C2=4		0,7
BE	Infrabel	37	BE-37	Y. Aguesses	Angleur	C1=2, C2=4		0,7
BE	Infrabel	37	BE-37	Angleur	Chenee	C1=2, C2=4		1,3
BE	Infrabel	37	BE-37	Chenee	Trooz	C1=2, C2=4		6,9
BE	Infrabel	37	BE-37	Trooz	Olne	C1=2, C2=4		1,9
BE	Infrabel	37	BE-37	Olne	Fraipont	C1=2, C2=4		0,9
BE	Infrabel	37	BE-37	Fraipont	Nessonvaux	C1=2, C2=4		1,6
BE	Infrabel	37	BE-37	Nessonvaux	Pepinster	C1=2, C2=4		5,1
BE	Infrabel	37	BE-37	Pepinster	Verviers-Central	C1=2, C2=4		4,2
BE	Infrabel	37	BE-37	Verviers-Central	Verviers-Palais	C1=2, C2=4		1,0
BE	Infrabel	37	BE-37	Verviers-Palais	Verviers-Est	C1=2, C2=4		1,4
BE	Infrabel	37	BE-37	Verviers-Est	Dolhain-Gileppe	C1=2, C2=4		4,7
BE	Infrabel	37	BE-37	Dolhain-Gileppe	Dolhain-Vicinal	C1=2, C2=4		1,3
BE	Infrabel	37	BE-37	Dolhain-Vicinal	Ligne 37-Signaux 1394	C1=2, C2=4		1,9
BE	Infrabel	37	BE-37	Ligne 37-Signaux 1394	Welkenraedt	C1=2, C2=4		3,0
BE	Infrabel	37	BE-37	Welkenraedt	Hergenrath (Frontière) - Aachen Süd Grenze	C1=4, C2=3		9,4
DE	DB	2600	DE-2600	Hergenrath (Frontière) - Aachen Süd Grenze	Aachen Hbf	F3	2	6,8
DE	DB	2564	DE-2564	Aachen Hbf	Aachen-Rothe Erde Pbf	F3	2	1,9
DE	DB	2600	DE-2600	Aachen-Rothe Erde Pbf	Düren Pbf	F3	2	29,2
DE	DB	2600	DE-2600	Düren Pbf	Köln-Ehrenfeld Pbf	F1	2	36,4
DE	DB	2608	DE-2608	Köln-Ehrenfeld Pbf	Köln Hbf	F1	2	2,5
DE	DB	2639	DE-2639	Köln Hbf	Köln Messe/Deutz	F3	2	1,2
DE	DB	2653	DE-2653	Köln Messe/Deutz	Köln-Mülheim	F3	2	3,6
DE	DB	2662	DE-2662	Köln-Mülheim	Köln-Mülheim Berliner Straße	F5	2	1,5
DE	DB	2658	DE-2658	Köln-Mülheim Berliner Straße	Köln Bruder Klaus Siedlung	F3	1	1,4
DE	DB	2650	DE-2650	Köln Bruder Klaus Siedlung	Langenfeld (Rheinl)	F2	1	13,3
DE	DB	2650	DE-2650	Langenfeld (Rheinl)	Düsseldorf-Reisholz Abzw	F2	1	10,9
DE	DB	2411	DE-2411	Düsseldorf-Reisholz Abzw	Düsseldorf-Lierenfeld	F5	2	5,4
DE	DB	2410	DE-2410	Düsseldorf-Lierenfeld	Düsseldorf-Derendorf Dnf	F5	2	4,2
DE	DB	2401	DE-2401	Düsseldorf-Derendorf Dnf	Düsseldorf-Derendorf Dn	Z1	2	1,2
DE	DB	2416	DE-2416	Düsseldorf-Derendorf Dn	Düsseldorf-Unterrath	F5	2	0,5
DE	DB	2670	DE-2670	Düsseldorf-Unterrath	Duisburg-Großenbaum	F6	2	9,8
DE	DB	2310	DE-2310	Duisburg-Großenbaum	Duisburg Hbf	F6	2	7,1
DE	DB	2650	DE-2650	Duisburg Hbf	Duisburg Kaiserberg	F3	2	2,5
DE	DB	2184	DE-2184	Duisburg Kaiserberg	Mülheim (Ruhr)-Styrum	F4	2	2,9
DE	DB	2300	DE-2300	Mülheim (Ruhr)-Styrum	Essen West	F4	2	11,1
DE	DB	2300	DE-2300	Essen West	Essen Hbf	F4	2	2,4
DE	DB	2164	DE-2164	Essen Hbf	Essen Hbf Ero	F6	2	2,2
DE	DB	2160	DE-2160	Essen Hbf Ero	Bochum Hbf	F4	2	13,8
DE	DB	2150	DE-2150	Bochum Hbf	Bochum Prinz von Preußen	F5	2	2,4
DE	DB	2158	DE-2158	Bochum Prinz von Preußen	Bochum-Lagendreer Lpf	F4	2	4,8
DE	DB	7448	DE-7448	Bochum-Lagendreer Lpf	Bochum-Lagendreer Bez Os	F4	2	1,2
DE	DB	2151	DE-2151	Bochum-Lagendreer Bez Os	Dortmund-Lütgendortmund Gbf	F5	2	2,4
DE	DB	2151	DE-2151	Dortmund-Lütgendortmund Gbf	Dortmund-Lütgendortmund	F5	2	1,2
DE	DB	2125	DE-2125	Dortmund-Lütgendortmund	Dortmund Hbf	F4	2	5,4
DE	DB	2106	DE-2106	Dortmund Hbf	Dortmund-Körne	F2	2	4,3
DE	DB	2650	DE-2650	Dortmund-Körne	Dortmund-Kurl	F2	2	5,6
DE	DB	2650	DE-2650	Dortmund-Kurl	Selmig	F2	2	15,9
DE	DB	2910	DE-2910	Selmig	Hamm (Westf) Rbf Hda	F5	2	1,4
DE	DB	2913	DE-2913	Hamm (Westf) Rbf Hda	Hamm (Westf) Rbf Hro	F5	2	1,6
DE	DB	2920	DE-2920	Hamm (Westf) Rbf Hro	Hamm (Westf) Rbf Hme	F5	2	1,1
DE	DB	2913	DE-2913	Hamm (Westf) Rbf Hme	Hamm (Westf) Rbf Hvn	F5	2	0,9
DE	DB	2250	DE-2250	Hamm (Westf) Rbf Hvn	Hamm (Westf) Pbf	F5	2	0,3
DE	DB	1700	DE-1700	Hamm (Westf) Pbf	Neubeckum Pbf	F2	2	21,3
DE	DB	2990	DE-2990	Neubeckum Pbf	Oelde	F5	2	8,9
DE	DB	1700	DE-1700	Oelde	Rheda-Wiedenbrück	F2	2	10,4
DE	DB	2990	DE-2990	Rheda-Wiedenbrück	Gütersloh Hbf	F5	2	8,9
DE	DB	1700	DE-1700	Gütersloh Hbf	Brackwede	F2	2	13,1
DE	DB	2990	DE-2990	Brackwede	Bielefeld Hbf Pbf	F5	2	4,3
DE	DB	1700	DE-1700	Bielefeld Hbf Pbf	Herford	F4	2	13,9
DE	DB	2990	DE-2990	Herford	Löhne (Westf) Pbf	F5	2	10,3
DE	DB	1700	DE-1700	Löhne (Westf) Pbf	Porta Westfalica	F4	2	16,4

		COUNTRY	FR	BE	DE	
Paris – Hannover			Paris	Wannehain (border) - Esplechin (border)	Hergenrath (border) - Aachen Süd Grenze	Hannover
		IM	RESEAU FERRE DE FRANCE	Infrabel	DB	

Country	**IM**	**Segment** **N°**	**Code**	**Points** **Departure**	**Arrival**	**Charging category**	**Usage category**	**D (km)**
DE	DB	2990	DE-2990	Porta Westfalica	Minden (Westf)	F5	2	4,2
DE	DB	1700	DE-1700	Minden (Westf)	Minden (Westf) Gbf	F4	2	1,4
DE	DB	1700	DE-1700	Minden (Westf) Gbf	Minden (Westf) NRW/NI	F2	1	2,9
DE	DB	1700	DE-1700	Minden (Westf) NRW/NI	Haste	F2	1	31,8
DE	DB	1700	DE-1700	Haste	Wunstorf	F2	1	6,9
DE	DB	1700	DE-1700	Wunstorf	Seelze Pbf	F2	2	10,3
DE	DB	7602	DE-7602	Seelze Pbf	Seelze Rbf West	F5	2	0,0
DE	DB	7636	DE-7636	Seelze Rbf West	Seelze Rbf Swf	F5	2	0,3
DE	DB	1750	DE-1750	Seelze Rbf Swf	Seelze Rbf Sob	F5	2	1,1
DE	DB	1701	DE-1701	Seelze Rbf Sob	Letter	F5	2	2,0
DE	DB	1701	DE-1701	Letter	Hannover Kurve	F5	2	0,9
DE	DB	1701	DE-1701	Hannover Kurve	Hannover Hbf	F5	2	3,5

DEFINITION OF THE VARIABLES:

RFF	- Time period: Departure at 8h00 (applicable to the charge for reservation of capacity). One single running direction taken into account.
INFRABEL	- Difference compared to the standard train-path : From 0,00% to 5%
	- Category of running priority: Category 1
	- Category of admissible weight on track: Category 2
	- Category H : Category 3 (> : running direction start-end)
DB	- Type of train-path: Express path
	- Load factor: Not applicable ⟹ Value equal to 1
	- Train without titling technology
	- Regional factors: Not applicable ⟹ Value equal to 1
	- Station category : • Hannover Hbf : Niedersachsen Länder and Category 1

RESULTS OF THE RAIL INFRASTRUCTURE CHARGE CALCULATION:

Link	**Infrastructure charge**										
	Country	**IM**	**Charge for the French part**								
			Charge for reservation of capacity				RCE (€)	RCTE (€)	**Total charge FR**		
			Access (€)	Path reservation (€)	Stops at stations (€)	Running (€)			**€**	**€/train-km**	**Index 100***
Paris – Hannover	FR	RFF	198,6	2.824,5	24,4	211,9	48,0	99,2	3.406,7	15,17	228
	Country	**IM**	**Charge for the Belgian part**								
			Charge train path - line (€)				Charge train path - facility (€)		**Total charge BE**		
									€	**€/train-km**	**Index 100***
	BE	Infrabel	666,8				0,0		666,8	2,80	42
	Country	**IM**	**Charge for the German part**								
			Utilisation charge (€)				Charge for stops at stations (€)		**Total charge DE**		
									€	**€/train-km**	**Index 100***
	DE	DB	1.577,5				26,3		1.603,8	4,08	62
	Remark : * The 100 index is the one amounting 100 for the average rail infrastructure charge (expressed in €/train-km) for the analysed link, considering all countries or infrastrucure managers.								**Total charge FR + BE+ DE**		
									€	**€/train-km**	**Index 100***
									5.677,2	6,63	100

Madrid – Wien		**COUNTRY**	ES	FR	CH	AT	DE	AT
			Madrid (Puerta de Atocha)	Cerbère La Plaine	State Border N. Charnitz (Buchs)	State Border N. Kufstein	Staatsgrenze N. Salzburg	Wien (Westbahnhof)
		IM	adif	RÉSEAU FERRÉ DE FRANCE	SBB CFF FFS	ÖBB	DB	ÖBB

FORMULA APPLIED :

(1) ADIF : Charge$^{(i)}$ = (Ch. for the use of infrastructure) + (Ch. for the use of stations) + (Security charge)

(2) RFF : Access charge $^{(ii)}$ = (Charges for minimum services) + (Charge for access to facilities)

(3) SBB : Charge$^{(iii)}$ = Charge for basic services

(4) ÖBB : Infrastructure charge$^{(iv)}$ = (Ch. for train movement) + (Ch. for stops at stations)

(5) DB : Price$^{(v)}$(train-path km) = (Base price) x (Product factor) x (Special factors) x (Regional factor) + (Stops at stations)

(i) The charge for the approval of railway staff training centres and the charge for the supply of additional, supplementary and ancillary services have not been considered in the calculation.
(ii) Charges for additional services not considered in the calculations.
(iii) The charge for supplementary services and for miscellaneous services has not been considered in the calculation.
(iv) The charges for shunting, parking, the use of other facilities and other services have not been considered in the calculations.
(v) Additive special factors not applicable to this calculation (value equal to 0).

OD SEGMENTATION:

Country	IM	Segment				Charging category	Usage category	D (km)	V (km/h)
				Points					
		N°	Code	Departure	Arrival				
ES	ADIF	200	ES-200	Madrid (Puerta de Atocha)	Guadalajara-Yebes	A.2		64,0	200
ES	ADIF	201	ES-201	Guadalajara-Yebes	Calatayud	A.2		157,0	200
ES	ADIF	202	ES-202	Calatayud	Zaragoza (Delicias)	A.2		86,0	200
ES	ADIF	203	ES-203	Zaragoza (Delicias)	Lleida	A.2		138,0	200
ES	ADIF	204	ES-204	Lleida	Plana P.	A.2		69,0	160
ES	ADIF	205	ES-205	Plana P.	Reus	A.2		21,0	140
ES	ADIF	206	ES-206	Reus	Tarragona	A.2		19,0	140
ES	ADIF	207	ES-207	Tarragona	Sant Vicenç de Calders	A.2		25,0	160
ES	ADIF	208	ES-208	Sant Vicenç de Calders	Barcelona (Sants)	A.2		60,0	160
ES	ADIF	209	ES-209	Barcelona	Arenys de Mar	C.1		44,0	140
ES	ADIF	210	ES-210	Arenys de Mar	Maçanet	C.1		37,0	140
ES	ADIF	211	ES-211	Maçanet	Girona	C.1		30,0	160
ES	ADIF	212	ES-212	Girona	Portbou	C.1		67,0	140
ES	ADIF	213	ES-213	Portbou	Cerbère	C.1		2,0	90
FR	RFF	54050	FR-54050	Cerbère	Elne	C		27,7	
FR	RFF	54049	FR-54049	Elne	Perpignan	C		13,6	
FR	RFF	52079	FR-52079	Perpignan	Narbonne	C		61,4	
FR	RFF	52078	FR-52078	Narbonne	Béziers	C		25,5	
FR	RFF	52077	FR-52077	Béziers	Sète	C		44,3	
FR	RFF	52076	FR-52076	Sète	Montpéllier	C		27,6	
FR	RFF	52075	FR-52075	Montpéllier	Les mazes-le-crès	B		6,5	
FR	RFF	52074C	FR-52074C	Les mazes-le-crès	St.-Césaire	B		39,5	
FR	RFF	52074B	FR-52074B	St.-Césaire	Nîmes	B		3,8	
FR	RFF	52074A	FR-52074A	Nîmes	Nîmes	B		5,1	
FR	RFF	54023	FR-54023	Nîmes	Villeneuve-les-Avignon	C		38,1	
FR	RFF	54022C	FR-54022C	Villeneuve-les-Avignon	Pont-St.-Esprit	C		44,3	
FR	RFF	54022A	FR-54022A	Pont-St.-Esprit	La voulte-sur-Rhône	C		68,6	
FR	RFF	54021B	FR-54021B	La voulte-sur-Rhône	Peyraud	C		58,8	
FR	RFF	54021A	FR-54021A	Peyraud	Givors-Canal	C		44,4	
FR	RFF	52037	FR-52037	Givors-Canal	Lyon-Perrache-Voyageurs	C		19,8	
FR	RFF	52006B	FR-52006B	Lyon-Perrache-Voyageurs	Lyon-Vaise	B		4,6	
FR	RFF	52006A	FR-52006A	Lyon-Vaise	Collognes-Fontaines	C		6,9	
FR	RFF	52027	FR-52027	Collognes-Fontaines	Lyon-St.-Clair	C		4,7	
FR	RFF	52030	FR-52030	Lyon-St.-Clair	Miribel	B		8,2	
FR	RFF	56055	FR-56055	Miribel	Ambérieu	B		34,8	
FR	RFF	54040	FR-54040	Ambérieu	Culoz	C		49,9	
FR	RFF	54041	FR-54041	Culoz	Bellegarde (Ain)	C		32,9	
FR	RFF	52062	FR-52062	Bellegarde (Ain)	Longéray-Léaz	C		5,2	
FR	RFF	54042	FR-54042	Longéray-Léaz	La Plaine	D		12,9	
CH	SBB	0	CH-0	La Plaine	State Border N. Charnitz (Buchs)	SBB		391,0	
AT	ÖBB	0	AT-0	State Border N. Charnitz (Buchs)	Innsbruck Westbahnhof	Other main lines		251,0	
AT	ÖBB	100	AT-100	Innsbruck	Wörgl	Kufstein-Innsbruck-Brenner			
AT	ÖBB	101	AT-101	Wörgl	State Border N. Kufstein	Kufstein-Innsbruck-Brenner			
DE	DB	7902	DE-7902	Kufstein	Kufstein Grenze	Z1	2	0,0	
DE	DB	5702	DE-5702	Kufstein Grenze	Rosenheim Süd	F3	2	29,9	
DE	DB	5707	DE-5707	Rosenheim Süd	Rosenheim Ost	F4	2	1,7	
DE	DB	5703	DE-5703	Rosenheim Ost	Prien am Chiemsee	F5	2	23,4	
DE	DB	5703	DE-5703	Prien am Chiemsee	Traunstein	F6	2	28,3	
DE	DB	5703	DE-5703	Traunstein	Freilassing	F7	2	24,4	
DE	DB	5703	DE-5703	Freilassing	Salzburg Grenze	F8	2	1,0	
AT	ÖBB	1	AT-1	Staatsgrenze N. Salzburg	Wien Estbahnhof	Westbahn		317,0	

Madrid – Wien		**COUNTRY**	ES	FR		CH	AT	DE	AT
			Madrid (Puerta de Atocha)	Cerbère	La Plaine	State Border N. Charnitz (Buchs)	State Border N. Kufstein	Staatsgrenze N. Salzburg	Wien (Westbahnhof)
		IM	adif	RÉSEAU FERRÉ DE FRANCE		SBB CFF FFS	ÖBB	DB	ÖBB

DEFINITION OF THE VARIABLES:

ADIF	- Level of traffic: N3.B (Level 3B : Operators > 15 million km·train/year)
	- Type of service: V2 (Top speed < 260 km/h)
	- Time period: Departure at 8h00 from Madrid (applicable to B and D charge for the use of railway lines modalities. One single running direction considered.
	- Renfe (2004): 172 M km·train
RFF	- Time period: Departure at 8h00 from Madrid (applicable to the path reservation charge). One single running direction considered.
SBB	- Type of traffic: Other than intermodal goods traffic (passenger traffic); traffic non requiring concession.
	- Type of train: Intercity / Eurocity (Hypothesis: TGV Duplex of 430 tonnes).
ÖBB	- Train's weight: 430 tonnes
	- Market segment: Passenger traffic
	- Traction unit category: Category A
	- Station category: • Wien Westbahnhof: Category 1
	- Hypothesis: • Without bottlenecks • Optimal performance regime: 0 minutes of delay
DB	- Type of train-path : Express path
	- Load factor: Not applicable ⟹ Value equal to 1
	- Train without titling technology
	- Regional factors: Not applicable ⟹ Value equal to 1

RESULTS OF THE RAIL INFRASTRUCTURE CHARGE CALCULATION:

Link	**Infrastructure charge**										
	Country	**IM**	**Charge for the Spanish part**								
			Lines utilisation				Station use (€)	Security (€)	**Total charge ES**		
			Access (€)	Reservation (€)	Operation (€)	Traffic (€)			**€**	**€/train-km**	**Index 100***
Madrid – Wien	ES	ADIF	6,6	163,8	458,1	2.076,8	250,3	97,5	3.053,0	3,73	139

Country	**IM**	**Charge for the French part**								
		Reservation of capacity				RCE (€)	RCTE (€)	**Total charge FR**		
		Access (€)	Path reservation (€)	Stops at stations (€)	Running (€)			**€**	**€/train-km**	**Index 100***
FR	RFF	10,1	731,5	0,0	650,5	147,5	304,6	1.844,2	2,68	76

Country	**IM**	**Charge for the Swiss part**							
		Minimum price				Supplements for nodes (€)	**Total charge CH**		
		Maintenance (€)	Train operation service (€)	Contribution margin (€)	Energy (€)		**€**	**€/train-km**	**Index 100***
CH	SBB	271,2	100,9	0,7	275,0	0,0	647,8	1,66	62

Country	**IM**	**Charge for the Austrian part**						
		Train movement			Stops at stations	**Total charge AT**		
		Standard package (€)	Mark ups and discounts (€)	TOTAL (€)	Standard package (€)	**€**	**€/train-km**	**Index 100***
AT	ÖBB	755,5	-10,0	745,5	0,0	745,5	2,97	111

Country	**IM**	**Charge for the German part**				
		Utilisation (€)	Stops at stations (€)	**Total charge DE**		
				€	**€/train-km**	**Index 100***
DE	DB	245,8	0,0	245,8	2,26	85

Country	**IM**	**Charge for the Austrian part**						
		Train movement			Stops at stations	**Total charge AT**		
		Standard package (€)	Mark ups and discounts (€)	TOTAL (€)	Standard package (€)	**€**	**€/train-km**	**Index 100***
AT	ÖBB	805,2	-12,7	792,5	5,5	798,0	2,52	94

Remark :
* The 100 index is the one amounting 100 for the average rail infrastructure charge (expressed in €/train-km) for the analysed link, considering all countries or infrastrucure managers.

Total charge ES + FR + CH + AT + DE + AT		
€	**€/train-km**	**Index 100***
7.334,2	2,85	100

ANNEX A8

CHARACTERISATION OF THE PRICING SYSTEMS IN THE UNITED KINGDOM, DENMARK AND SWEDEN

A8.1. BRITISH RAIL INFRASTRUCTURE CHARGING SYSTEM

The current British infrastructure manager, Network Rail, was created in October 2002 as a result of it taking over Railtrack plc, which was the owner and operator of the national railway network.

The legal framework for rail infrastructure charges is defined in the Railways Act 1993, Statutory Instruments number 1340 of 1998 (The Railways Regulations 1998) and in the Transport Act 2000, which amended the Railways Act 1993. According to this legal framework, the Office of Rail Regulation (ORR) defines the structure and the amount of charging elements and reviews them periodically through its access charges reviews.

The charging philosophy applied is MC+ for passengers (franchised train operators) and MC for freight and open access operators. With regard to the charging structure, the current structure of tariffs is two-part for passenger transport (franchised train operators) and linear for freight transport, designed for covering fully maintenance, renewal and traffic management costs. According to CEMT (2005), in terms of maintenance costs, fixed costs account for 77% whilst the remaining 23% is variable. For renewals costs, fixed costs account for 93% whilst the remaining 7% is variable.

The structure and values of the fixed and variable charges have been summarised in annex A3.

Variable charges for passenger transport are designed so that Network Rail recovers the costs which vary with the volume of traffic (Thomas, 2004). They are divided into:

- *Track usage charge*: This charge, expressed in pence per vehicle mile and variable according to the type of vehicle, covers the marginal costs of operation (maintenance and renewal of track, signalling and structures assets). Its values are the result of the application of a top-down model analysis that estimates the variability of total maintenance, operation and renewal costs by asset category for the whole network, and their subsequent allocation to individual vehicles by using engineering relationships describing the damage caused to the infrastructure for different operating characteristics, such as speed, axle load, unsprung mass, etc. (CENIT et al, 2007a).

- *Traction electricity charge*: This charge covers the cost of electricity procurement and supply. It is composed by a base tariff, expressed in pence per kWh, that is multiplied by a coefficient that varies according to the season of the year and the geographical zone, as well as to the type of day (working day, weekend) and the time of the day (three time periods are distinguished).

- *Track capacity charge*: This charge covers the marginal congestion cost and varies according to each service group for franchised passenger train operators.

- *Rail safety charge*: This charge is calculated pro rata to the share attributed to the Train Operator of the aggregate total fixed track charge.

With regard to fixed charges, the values (which are independent of traffic intensity) are the result of the calculations made by ORR for a five-year period by allocating to routes the total amount that Network Rail should recover and dividing it among the different franchised passenger train operators on the basis of vehicle miles operated. Fixed charges constitute therefore mark ups to ensure Network Rail recovers all its costs and, according to Thomas (2004), they are allocated based implicitly on ability to pay through the franchising process. According to Nash (2004), the fixed element covers the avoidable costs[30] (i.e. not just variable costs but also any fixed costs that would be avoided if the particular set of devices were no longer running) plus a share of all remaining joint and fixed costs.

In addition to fixed and variable charges, the charging structure is composed of supplementary access charges, which constitute the performance and possessions regimes, aimed at incentivising both railway operators and the infrastructure manager.

The structure of charges presented in the precedent paragraphs gives rise to a two-part tariff structure where the fixed component of the charge has a very important weight: around 50% and above (almost 70% for the Manchester – Birmingham link), as can be seen in **table A8.1**.

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[30] The definition of avoidable costs is presented in chapter 1, section 1.2.1.3.

TABLE A8.1 WEIGHT OF THE FIXED AND VARIABLE CHARGES FOR BRITISH NATIONAL HIGH PERFORMANCE LINKS
Source: Sánchez-Borràs from data from the official documents on rail infrastructure charging in the UK (see table 3.7)

Link	Fixed charge		Variable charge	
	In €	% fixed/total	In €	% variable/total
London – Edinburgh	2.330,3 €	48,3 %	2.491,1 €	51,7 %
London – Newcastle	2.017,3 €	48,6 %	2.130,6 €	51,4 %
Manchester – Birmingham	1.235,7 €	68,3 %	574,1 €	31,7 %

Remark: In order to allocate the fixed charge to each one of the links considered, the value given by the British IM was divided by the total train-km run each year in the corridor analysed and multiplied by the length of the link for which the infrastructure charge was to be calculated.

A8.2. DANISH RAIL INFRASTRUCTURE CHARGING SYSTEM

The current Danish infrastructure manager, Banedanmark (previously Banestyrelsen), was created in 1997 and is currently funded through State subsidies and infrastructure charges since 1999.

The current legal framework for rail infrastructure charges is defined in the Railways Act n.155 of March 15th 2003 and in Act n. 1171 of December 12th 2004, which states the charging rates.

The Danish charging system, which is aimed at covering the short-term socio-economic marginal costs, partly covers, according to ECMT (2005), investment expenditures, maintenance and traffic management costs. In addition, according to Elm-Larsen (2004), the political objective for infrastructure charges is to finance the fixed links (mainly the Great Belt and the Öresund bridges) by users. Nonetheless, since competition reasons against road transport did not allow to claim all charges at the bridge, higher charges have been implemented at connecting lines, especially the connection with Sweden and Germany respectively. As a result of this, trains running along the whole corridor (land, bridge and tunnel) pay approximately Banedanmark’s relative share of payment for the fixed links, and the charging system can be considered CM+ with a linear structure.

The structure and the tariffs of the Danish pricing system are the ones presented in annex A3, according to the data published in Banedanmark’s Network Statement for the year 2006.

Charges are composed of an infrastructure charge and a capacity charge, as well as environmental subsidies and a cancellation charge, and additional and auxiliary charges.

The infrastructure charge is made up by two different charges:

- A kilometres fee due by all trains (1,84 DKK/train-km), determined through an average train’s operation on the infrastructure (CENIT et al, 2007a, from Banedanmark’s 2006 Network Statement) and which includes supplementary charges for operating on the Danish network (except for the Korsør-Nyborg and Öresund Coast – Swedish border lines).

- A tariff for the use of the Danish part of the Great Belt and the Öresund bridges, differentiated per type of traffic (passenger, freight) and levied per train. On the Great Belt, passenger trains pay more than freight trains, whilst on the Öresund bridge it is the opposite way round.

The capacity charge is only levied in three sections of the network, per train and type of traffic (passenger, freight), reflecting the scarcity of capacity on those sections.

Finally, environmental subsidies are only granted to conventional and combined freight transport between and to a Danish station as well as to intermodal freight transport in transit through Denmark.

A8.3. SWEDISH RAIL INFRASTRUCTURE CHARGING SYSTEM

The current Swedish infrastructure manager, Banverket, was created in 1988 by the law of Transport Politics.

The current legal framework for rail infrastructure charges is regulated by the Parliament, which is in charge of amending and approving the infrastructure charges calculated by the Ministry of Transports and Communications and Banverket.

Infrastructure charges for the use of the Swedish railway network are based on the short-term socio-economic marginal costs. Hence, charges partly cover maintenance and traffic management costs, as well as some external costs. Renewal and investment costs are wholly paid by the Swedish Government. The level of charges (marginal) is determined by means of an econometric model. The cost recovery rates are established comparing the average costs to the calculated marginal costs. In 2004, the cost recovery rate of charges was 5% and the pricing philosophy MC+, with a linear tariff structure.

In annex A3 the structure and the tariffs of the Swedish pricing system have been summarised according to the data published in Banverket’s Network Statement for the year 2006. Charges are divided into charges for the minimum package of services, charges for track access services, accident charge and charges for ancillary and additional services.

The charge for the minimum package of service is composed of four different charges, namely:

- *Track charge*: This charge, expressed in monetary value per gross tonne-kilometres and distinguishing per type of traffic (passenger, freight), is supposed to reflect the wear and tear marginal costs. Nevertheless, according to Ekstrom (2004), two-thirds of the track charges is an “overall” mark up for the Öresund bridge (considered a high speed line). For secondary lines, infrastructure charges cover 30% of the maintenance costs.

- *Charges for freight traffic on the* Ö*resund bridge*: This charge is a mark up applied to freight traffic using the Öresund bridge. It is levied per freight train crossing the Öresund bridge and is intended to recover part of investment costs.

- *Passenger information fees*: These fees are charged to passenger trains in monetary value per gross tonne kilometre. According to its value, this charge could also contain a mark up for recovering part of the Öresund bridge’s investment costs.

- *Diesel charge*: This charge, which varies with the consumed diesel litres and the type of traffic and vehicle, is intended to reflect the costs of emissions of carbon dioxide (CO_2) and the costs of emissions of nitrogen oxides (NO_x), i.e. the socio-economic marginal costs in terms of environmental and health effects.

With regard to the accident charge, variable with the number of train-km and the type of traffic, it reflects the socio-economic marginal costs of accidents involving injury.

ANNEX A9

RAIL INFRASTRUCTURE CHARGES FOR INTERNATIONAL SERVICES RUNNING ON THE EUROPEAN HIGH SPEED NETWORK

A9.1. INTRODUCTION

In chapter 4 we have seen that high speed or high performance services running on high speed or high performance lines are charged, in general terms, a higher amount in terms of use of the infrastructure than those running on conventional lines. As has been presented, these higher charges are often the result of the application, by pricing systems, of mark ups based on wear and tear costs and mark ups reflecting investment costs and/or the commercial position of the high speed railway market. The consideration of these aspects varies from country to country.

Currently, infrastructure charges for an international European link are calculated as the sum of charges resulting from the application of the corresponding national pricing system to each national section, like it used to be the case for ticket fares before an integrated international tariff was introduced. The different ways of structuring charges in countries placed along international European corridors could therefore constitute an obstacle to international services on the high speed railway network.

The present section is devoted to analysing and quantifying the differences in charges for international services running on high performance links, and seeing to what extent they can represent a barrier for international services.

A9.2. ANALYSIS OF THE BARRIERS INTRODUCED BY THE CURRENT CHARGING SYSTEMS FOR INTERNATIONAL SERVICES

Table A9.1 provides a first glimpse of how the amount of charges is distributed along the different national sections, by means of the average rail infrastructure charges index per country, 100 being equivalent to the average infrastructure charge of the link.

TABLE A9.1 AVERAGE RAIL INFRASTRUCTURE CHARGE INDEX (Base 100 = average infrastructure charge of the link, expressed in €/train-km)
Source : Sánchez-Borràs for CENIT (2006)

OD N°	Countries (codes)	OD		Average rail infrastructure charge index per country (C.i)						Av. charge of the link (€/tr-km)
		Origin	Destination	C.1	C.2	C. 3	C. 4	C. 5	C. 6	
1 BORDER CROSSED										
1	DK – SE	København	Malmö	176 (DK)	3 (SE)					5,1
3	SK – AT	Bratislava	Wien	100 (SK)	100 (AT)					1,9
4	FR – BE	Lille	Bruxelles	87 (FR)	103 (BE)					10,4
8	SI – IT	Ljubljana	Trieste	88 (SI)	150 (IT)					3,1
10	FR – CH	Lyon	Genève	104 (FR)	56 (CH)					3,5
11	FR – DE	Strasbourg	Stuttgart	94 (FR)	100 (DE)					4,6
15	NL – BE	Amsterdam	Bruxelles	44 (NL)	201 (BE)					4,1
17	AT – DE	Wien	Nürnberg	83 (AT)	123 (DE)					3,0
24	BE – DE	Bruxelles	Köln	86 (BE)	123 (DE)					3,9
28	CZ – DE	Praha	Berlin	40 (CZ)	138 (DE)					2,8
30	CZ – AT	Praha	Wien	87 (CZ)	147 (AT)					1,3
31	NL – DE	Amsterdam	Berlin	46 (NL)	121 (DE)					3,7
34	FR – CH	Paris	Genève	102 (FR)	19 (CH)					10,1
35	PL – DE	Warszawa	Berlin	100 (PL)	103 (DE)					3,9
37	CZ – DE	Praha	München	27 (CZ)	154 (DE)					4,1
38	SE – NO	Stockholm	Oslo	0 (NO)	133 (SE)					0,5
41	PT – ES	Lisboa	Madrid	113 (PT)	93 (ES)					1,2
42	ES – FR	Barcelona	Bordeaux	98 (ES)	101 (FR)					2,2
43	ES – FR	Barcelona	Lyon	52	116					3,2

OD	Countries (codes)	OD		Average rail infrastructure charge index per country (C.i)						Av. charge of the link (€/tr-km)
N°		Origin	Destination	C.1	C.2	C. 3	C. 4	C. 5	C. 6	
				(ES)	(FR)					
48	DK – DE(3)	København	Köln	8 (DK)	8 (DKDE)	130 (DE)				3,0
49	FR – DE	Strasbourg	Nürnberg	108 (FR)	100 (DE)					2,1
55	UK – FR(2)	London	Bordeaux	38 (UK)	1454 (FRUK)	32 (FR)				21,9
58	ES – FR	Barcelona	Paris	57 (ES)	108 (FR)					3,0
59	DE – AT	Hamburg	Wien	113 (DE)	61 (AT)					4,1
60	PT – ES	Lisboa	Barcelona	43 (PT)	1113 (ES)					3,0
65	FR – IT	Paris	Roma	173 (FR)	43 (IT)					5,9
66	UK – FR(2)	Glasgow	Rennes	44 (UK)	1725 (FRUK)	45 (FR)				18,7
2 BORDERS CROSSED										
26	UK – FR – BE(2)	London	Bruxelles	17 (UK)	658 (FRUK)	10 (FR)	22 (BE)			48,3
33	FR – BE – NL	Paris	Amsterdam	198 (FR)	42 (BE)	22 (NL)				7,7
44	NO – SE – DK	Oslo	København	0 (NO)	77 (SE)	1161 (DK)				0,8
45	PL – CZ – AT	Warszawa	Wien	124 (PL)	58 (CZ)	97 (AT)				1,9
47	FR – BE – DE	Paris	Hannover	228 (FR)	42 (BE)	62 (DE)				6,6
50	IT – CH – DE	Milano	Köln	199 (IT)	51 (CH)	120 (DE)				3,4
52	DE – AT – IT	München	Roma	158 (DE)	110 (AT)	91 (IT)				2,7
53	DE – DK – SE(3)	Hamburg	Stockholm	306 (DE)	20 (DKDE)	111 (DK)	48 (SE)			1,2
54	NL – DE – PL	Amsterdam	Warszawa	45 (NL)	117 (DE)	102 (PL)				3,8
61	FR – BE – NL	Marseille	Amsterdam	122 (FR)	38 (BE)	21 (NL)				8,3
62	CZ – DE – FR	Praha	Paris	33 (CZ)	120 (DE)	86 (FR)				3,3

OD N°	Countries (codes)	OD		Average rail infrastructure charge index per country (C.i)						Av. charge of the link (€/tr-km)
		Origin	Destination	C.1	C.2	C. 3	C. 4	C. 5	C. 6	
63	FR – DE – AT	Paris	Wien	91 (FR)	123 (DE)	76 (AT)				3,3
64	LU – DE – PL	Luxembourg	Warszawa	148 (LU)	104 (DE)	88 (PL)				4,4
69	ES – FR – CH	Madrid	Zürich	144 (ES)	73 (FR)	42 (CH)				3,7
70	DE – DK – SE(3)	München	Stockholm	161 (DE)	9 (DKDE)	48 (DK)	21 (SE)			2,8
71	ES – FR – BE	Madrid	Bruxelles	27 (ES)	125 (FR)	359 (BE)				3,0
3 BORDERS CROSSED										
56	CH – AT – DE – AT(4)	Genève	Wien	77 (CH)	169 (DE)	103 (AT)				2,3
67	FR – BE – DE – PL	Paris	Warszawa	279 (FR)	52 (BE)	80 (DE)	71 (PL)			5,4
74	PT – ES – FR – CH	Lisboa	Genève	50 (PT)	117 (ES)	88 (FR)	62 (CH)			2,6
4 BORDERS CROSSED										
51	UK – FR – BE – LU – FR(2), (4)	London	Strasbourg	38 (UK)	1761 (FRUK)	9 (BE)	28 (LU)	15 (FR)		21,7
72	UK – FR – BE – DE – PL(2)	London	Warszawa	62 (UK)	2386 (FRUK)	38 (FR)	21 (BE)	33 (DE)	29 (PL)	13,3
5 BORDERS CROSSED										
68	CH – AT – D E – AT – CZ – PL(4)	Zürich	Warszawa	62 (CH)	75 (ATDE)	153 (DE)	96 (AT)	46 (CZ)	99 (PL)	2,4
73	ES – FR – CH – AT – DE – AT(1)	Barcelona	Wien	69 (ES)	97 (FR)	73 (CH)	150 (DE)	103 (AT)		2,4
75	ES – FR – CH – AT – DE – AT(1)	Madrid	Wien	139 (ES)	76 (FR)	62 (CH)	85 (DE)	102 (AT)		2,8

Remarks :

- For links 26, 69, 78 and 95, which cross the Öresund link, the charges to be paid for crossing this link are included in the charges to be paid to the Danish and the Swedish IM.

(1) For the Barcelona – Wien and Madrid – Wien links, the average rail infrastructure charge index for Austria corresponds to the total charge to be paid for running in Austria.

(2) For links crossing the Channel Tunnel, only the passage from one country to another was regarded as a border. Thus, for example, the London – Bruxelles link was classified with the countries crossing two borders, since it crosses the Anglo-Frech border and the Franco-Belgian border. Nevertheless, the Channel Tunnel could be considered as a border point, because of its charging characteristics.

(3) The links crossing the border between Denmark and Germany by Rodby and Puttgarden have been classified with the links crossing one border. Nevertheless, because of the charging characteristics of the ferry between Rodby and Puttgarden, these links could have been described as links crossing two border points.

(4) Same remark as for Madrid – Wien link(1).

FIGURE A9.1 RAIL INFRASTRUCTURE CHARGING SITUATION IN THE MADRID-VIENNA LINK

Source: Sánchez-Borràs for CENIT (2006)

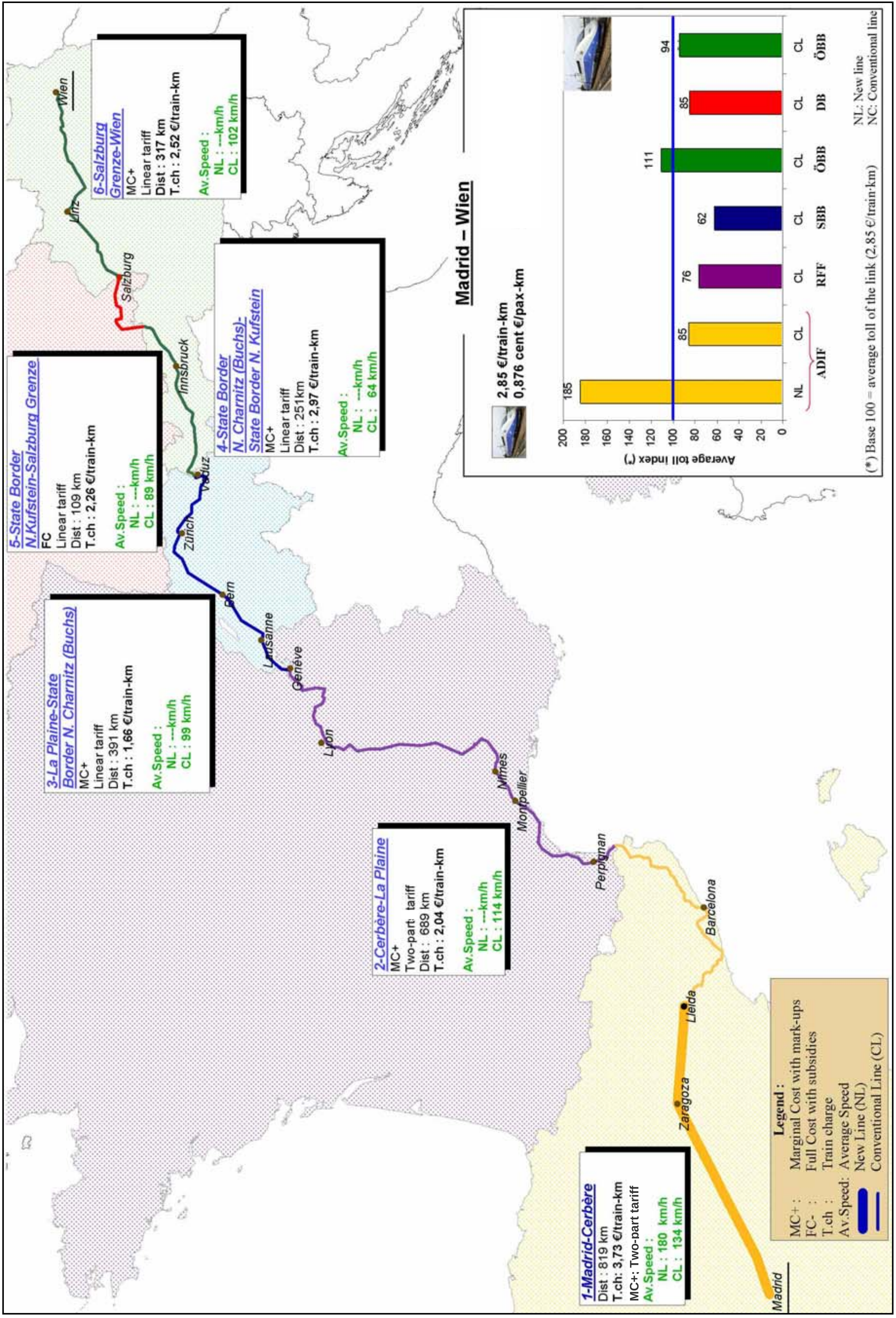


FIGURE A9.2 RAIL INFRASTRUCTURE CHARGING SITUATION IN THE PARIS-HANOVER LINK

Source: Sánchez-Borràs for CENIT (2006)

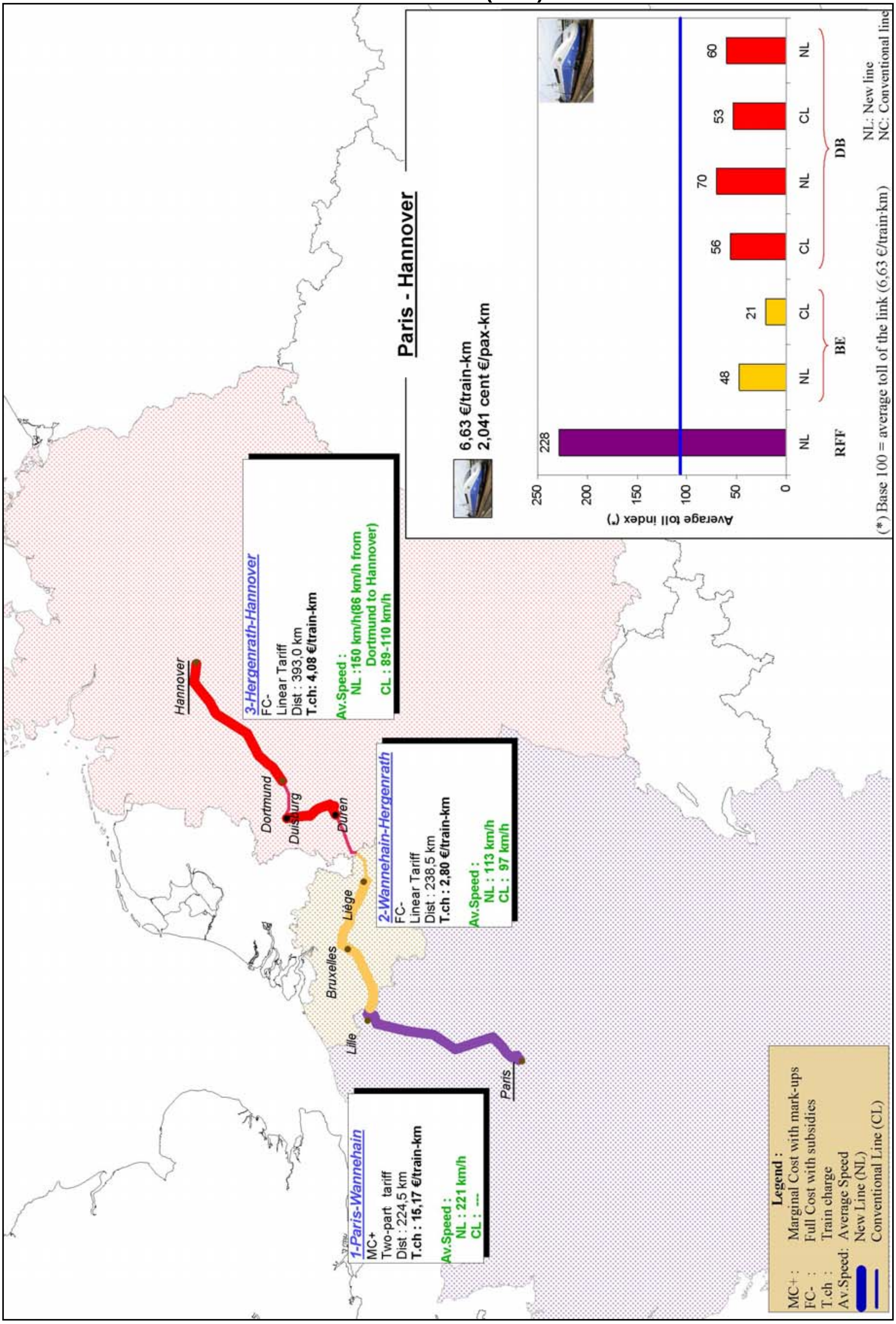


TABLE A9.2 BORDER POINTS ANALYSED

Border		Border point	ODs crossing the border point[1]								
1	DK-SE	Öresund	26	69	78	95					
2	SK - AT	Devínska Nová Ves štátna hranica-Staatsgrenze N. Marchegg	28								
3	FR - BE	Wannehain Frontière/Esplechin Border	29	51	58	72	86	92	96	97	76
4	SL - IT	Sežana d.m./Villa Oficina	33								
5	FR - CH	La Plaine	35	94	59	98	99	100			
6	FR - DE	a Strabourg-Port-du-Rhin/Kehl Grenze	36	74	88						
		b Stiring-Wendel- Saarbrücken Grenze	87								
7	NL - BE	Essen-Grens	40	58	86						
8	AT - DE	a Passau Grenze/State Border N. Pyret	42	84							
		b Kufstein Grenze - State Border N. Kufstein	77	81	100						
		c State Border N. Lochau-Hörbranz – Lindau	93	98							
		d Salzburg Grenze	81	88	93	98	100				
9	BE - DE	Hergenrath (Frontière)/Aachen Süd Grenze	49	72	92	97					
10	UK - FR	Eurotunnel	51	76	80	91	97				
11	CZ - AT	Břeclav St. Hr. - State Border N. Bernhardsthal	55	70	93						
12	NL - DE	Bad Bentheim Grenze	56	79							
13	PL - DE	Frankfurt (Oder) Grenze - Kunowice(GR)	60	79	89	92	97				
14	CZ - DE	a Cheb st. hr./Schirnding Grenze	62								
		b Dolní Zleb (st. Hr)	87	53							
15	SE - NO	a Kornsjö	69								
		b Charlottenberg	63								
16	PT - ES	PK 428,5 (Frontera)	66	85	99						
17	ES - FR	a Hendaye	96								
		b Cerbère	67	68	83	94	98	99	100		
18	PL - CZ	Zebrzydowice (GR)	70	93							
19	DK - DE	Puttgarden - Rodby	73	78	95						
20	IT - CH	Chiasso	75								
21	CH - DE	Basel St. Johann - Weil am Rhein	75								
22	AT - IT	State Border N. Brenner	77								
23	CH - AT	a St. Margrethen (State Border)	93	98							
		b State Border N. Charnitz (Buchs) Buchs SG - State Border N. Schaan-Vaduz	100	81							
24	LU - BE	Aubange Frontière - Rondange Frontière	76								
25	LU - FR	Apach (Moselle) Frontière	76								
26	LU - DE	Igel Grenze	89								
27	IT -FR	Modane	90								

Remarks:

[1] The numbering corresponds to the one defined in **table 3.4**

The differences in indexes are very variable, and in particular very noticeable in the links crossing the Channel Tunnel (British-French border), followed by the links crossing the Öresund connection (Danish-Swedish border). In the links where there are no big civil works, the average rail infrastructure charge index per country varies to a lesser extent than in the abovementioned cases, even if differences in values are also observed, as it was to be expected from the characterisation of the national pricing systems presented in the preceding sections.

In **figures A9.1** and **A9.2** the results for the Madrid – Vienna and the Paris – Hanover links have been outlined, in order to graphically present the differences to which reference is being made. The graphs placed at the bottom right hand corner of both of the aforementioned figures show the weight of the infrastructure charges per country and per type of infrastructure (new and upgraded line –NL– and conventional line –CL–).

While in a single country infrastructure charges vary according to different variables (type of infrastructure, commercial speed, among other aspects), at the borders between two countries, the charge to be applied at both sides of the border would be expected to remain the same if there was a single IM managing all the European network. Therefore, it is of interest to analyse and quantify those differences at border points.

Table A9.2 presents the border points analysed (35 border points, which correspond to 27 European borders) and indicates the international links crossing them and for which infrastructure charges were calculated.

In **figures A9.3-a** and **A9.3-b** the value of the rail infrastructure charge (expressed in €/train-km) in the border segments of the 35 border points analysed has been quantified. **Table A9.3** and **figure A9.4** numerically and graphically summarises the "gap" in rail infrastructure charges between one side and the other of the different border points analysed. For the links where the calculation of the rail infrastructure charge requires taking into account the time period, the values presented correspond to the ones obtained for a train departing at 8 a.m. from the origin point of the link crossing the border point analysed.

The results obtained show that there is a great dispersion in the order of magnitude of the "gaps" in rail infrastructure charges in the border segments. It is to be noted that:

- Differences in charges in the borders of the Southern European countries (Portugal–Spain, Spain–France) are about [5; 10[€/train-km in the Spanish-

Portuguese border, and about [2; 3[€/train-km in the Spanish-French borders (Hendaye and Cerbère).

- Differences in infrastructure charges in the Eastern French borders (borders with Italy, Switzerland and Germany) are below 3 €/train-km. In the Northern French borders, the differences in infrastructure charges are higher for the borders that are situated on the West side.

FIGURE A9.3-a "GAP" IN RAIL INFRASTRUCTURE CHARGES IN THE BORDER POINTS ANALYSED

Source : Sánchez-Borràs for CENIT (2006)

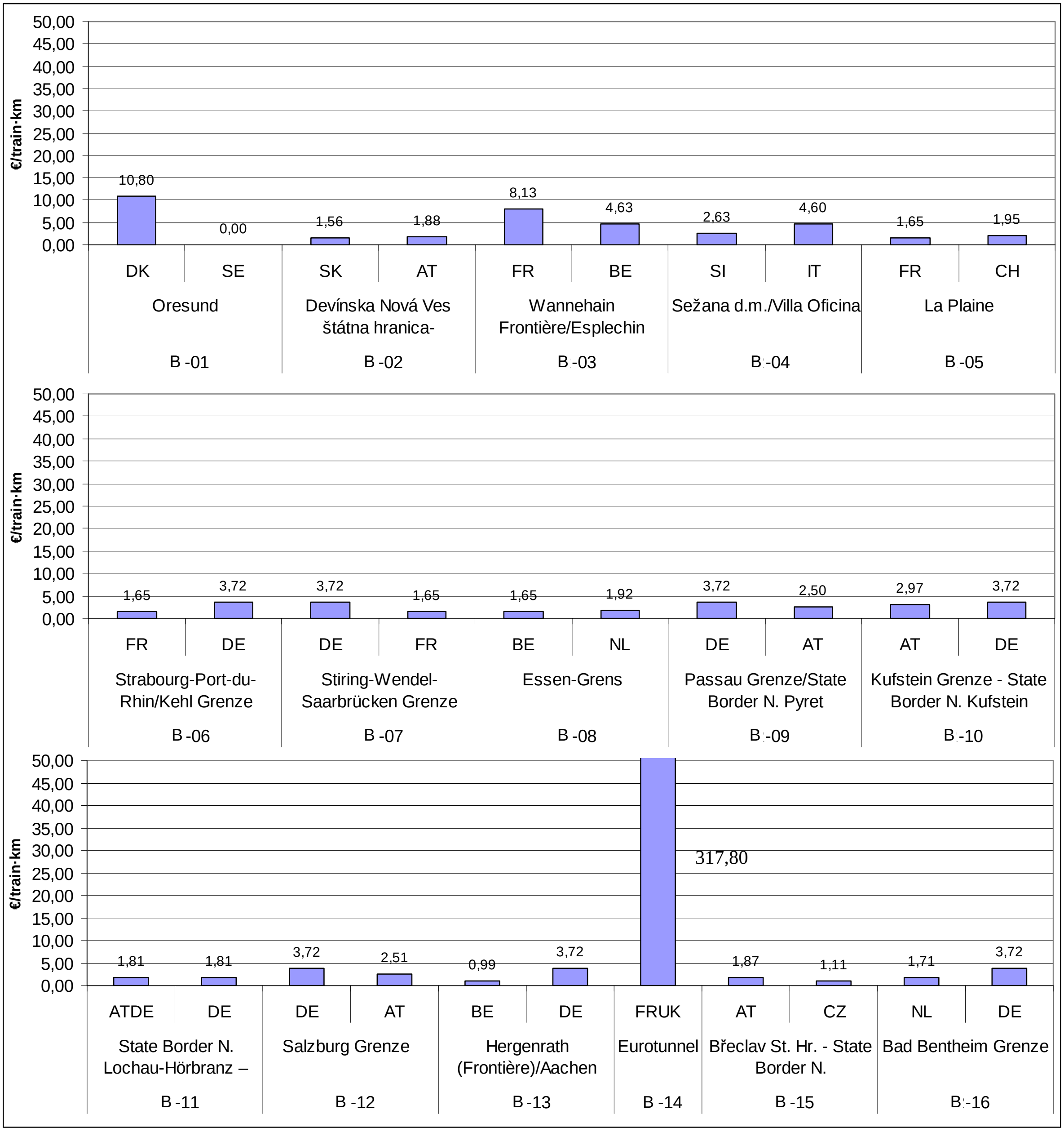


FIGURE A9.3-b “GAP” IN RAIL INFRASTRUCTURE CHARGES IN THE BORDER POINTS ANALYSED

Source : Sánchez-Borràs for CENIT (2006)

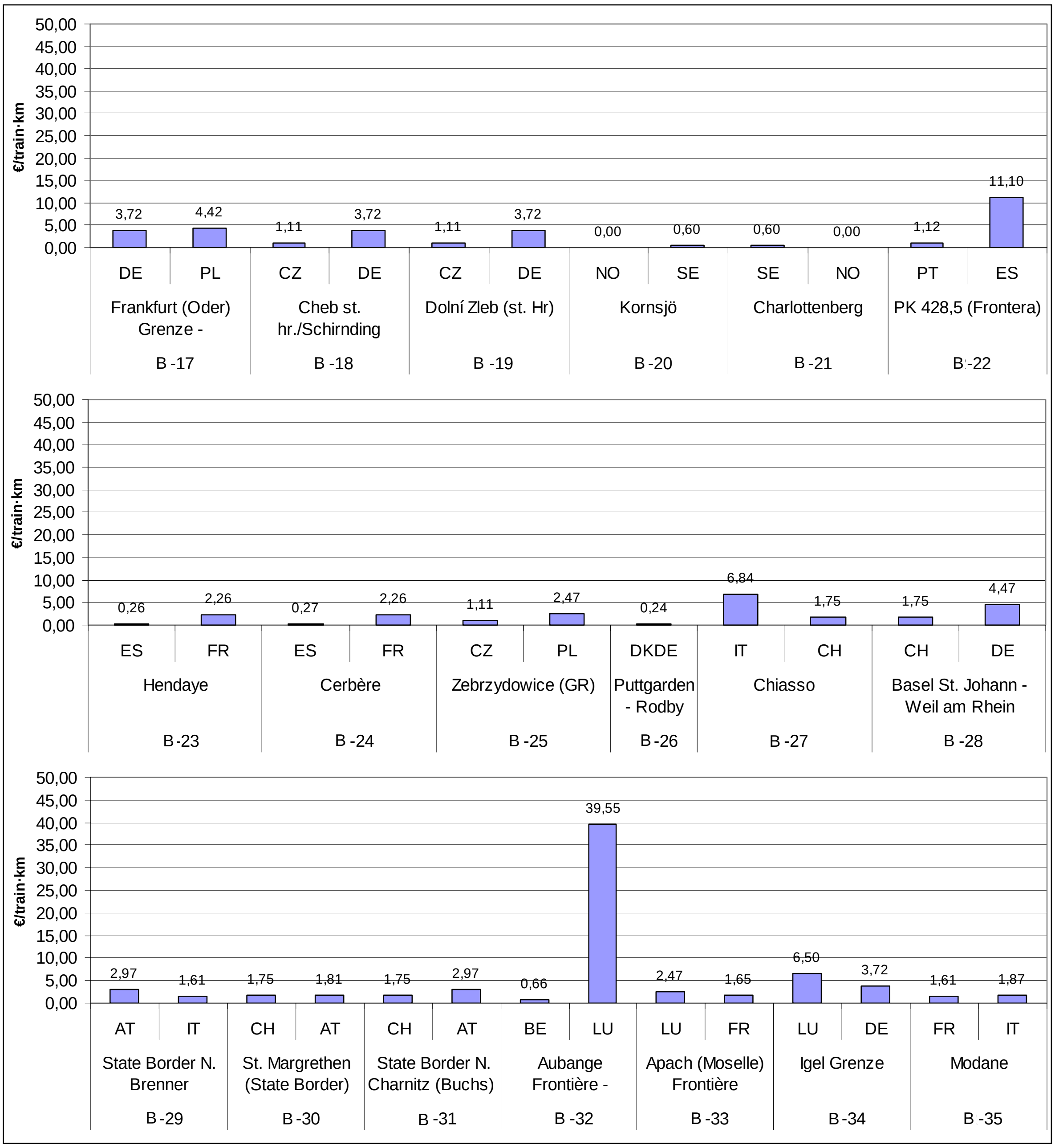


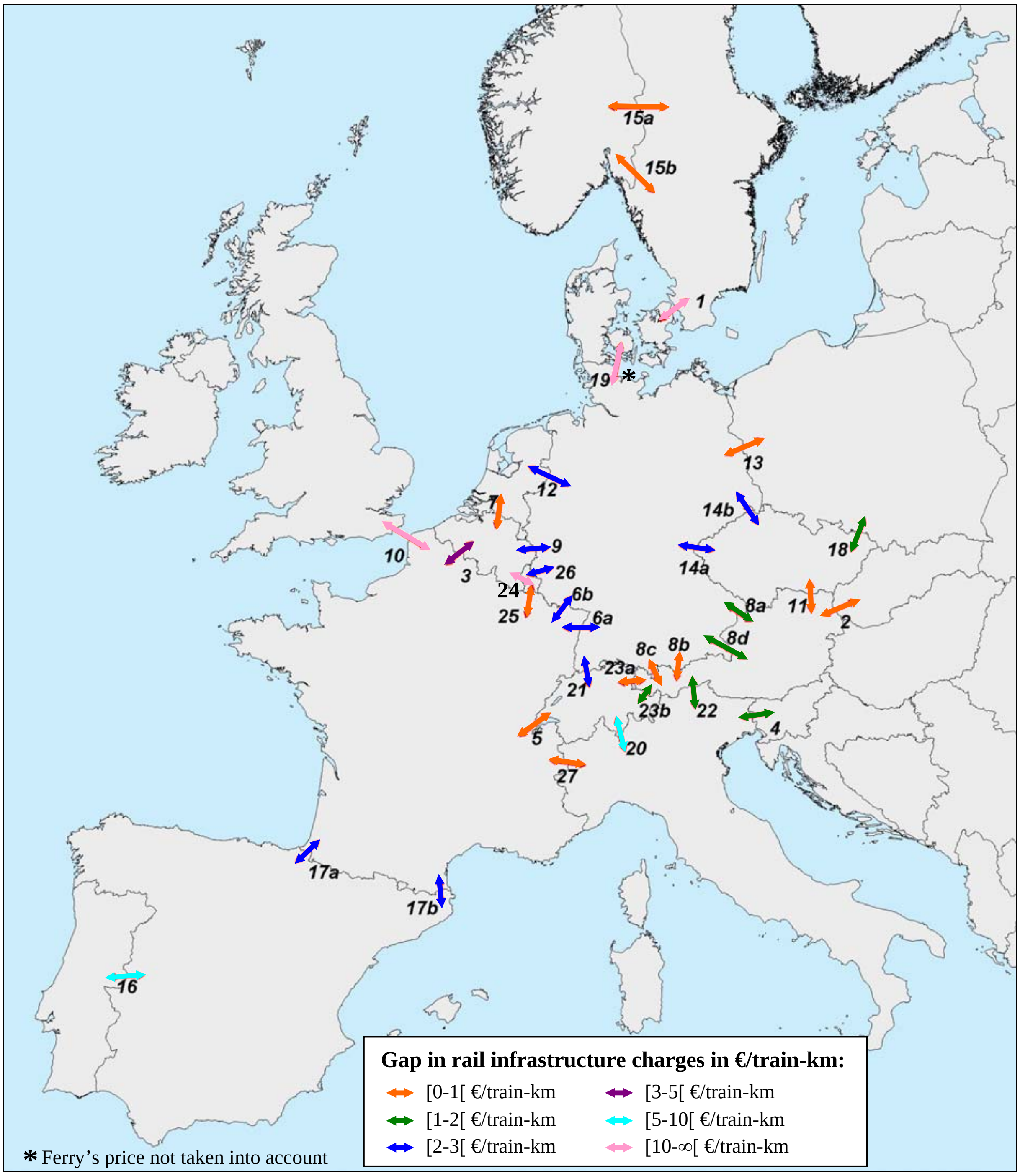
TABLE A9.3 “GAP” IN RAIL INFRASTRUCTURE CHARGES IN THE BORDER POINTS ANALYSED

Border	Border point	“Gap” (in €/train-km)
1 DK - SE	Öresund	10,6 (Danish side) 10,2 (Swedish side)
2 SK - AT	Devínska Nová Ves štátna hranica-Staatsgrenze N. Marchegg	0,32
3 FR - BE	Wannehain Frontière/Esplechin Frontière	3,50
4 SL - IT	Sežana d.m./Villa Oficina	1,97
5 FR - CH	La Plaine	0,30
6 FR - DE	a Strabourg-Port-du-Rhin/Kehl Grenze	2,07
	b Stiring-Wendel- Saarbrücken Grenze	2,07
7 NL - BE	Essen-Grens	0,27
8 AT - DE	a Passau Grenze/State Border N. Pyret	1,22
	b Kufstein Grenze - State Border N. Kufstein	0,75
	c State Border N. Lochau-Hörbranz – Lindau	0
	d Salzburg Grenze	1,25
9 BE - DE	Hergenrath (Frontière)/Aachen Süd Grenze	2,73
10 UK - FR	Eurotunnel	309,6 (English side) 313,36 (French side)
11 CZ - AT	Břeclav St. Hr. - State Border N. Bernhardsthal	0,76
12 NL - DE	Bad Bentheim Grenze	2,01
13 PL - DE	Frankfurt (Oder) Grenze - Kunowice(GR)	0,70
14 CZ - DE	a Cheb st. hr./Schirnding Grenze	2,61
	b Dolní Zleb (st. Hr)	2,61
15 SE - NO	a Kornsjö	0,60
	b Charlottenberg	0,60
16 PT - ES	PK 428,5 (Frontera)	9,98
17 ES - FR	a Hendaye	2,00
	b Cerbère	2,00
18 PL - CZ	Zebrzydowice (GR)	1,36
19 DK - DE	Puttgarden - Rodby	(1)
20 IT - CH	Chiasso	5,09
21 CH - DE	Basel St. Johann - Weil am Rhein	2,72
22 AT - IT	State Border N. Brenner	1,36
23 CH - AT	a St. Margrethen (State Border)	0,06
	b State Border N. Charnitz (Buchs) Buchs SG - State Border N. Schaan-Vaduz	1,22
24 LU - BE	Aubange Frontière - Rondange Frontière	38,89
25 LU - FR	Apach (Moselle) Frontière	0,82
26 LU - DE	Igel Grenze	2,78
27 IT - FR	Modane	0,26

Remarks :

(1) For the Puttgarden – Rodby border point, where the link is guaranteed by a ferry service, the charges to be paid for the use of the ferry service have not been counted in the total rail infrastructure charge. Its cost amounts approximately 25€ per occupied metre. The fact that the on-ferry track is only 118m long has not been taken into account when choosing the itinerary for the links crossing the German–Norwegian border. Nevertheless, is has to be pointed out that the standard train chosen for the analysis, the TGV Duplex, is approximately 200m long.

FIGURE A9.4 “GAP” IN RAIL INFRASTRUCTURE CHARGES IN THE BORDER POINTS ANALYSED
Source : Sánchez-Borràs et al (2008b)



- Differences in infrastructure charges in the German Western borders (with the Netherlands, Belgium, France and the West of Switzerland) are about 2-3 €/train-km.

- Differences in infrastructure charges in the Southern German borders (borders with Austria) are lower than 2 €/train-km.

- In the Eastern German borders (borders with Poland and Czech Republic), differences in infrastructure charges are lower than 3 €/train-km.

- In the Scandinavian borders (Norway, Sweden, Denmark), differences in infrastructure charges are all lower than 1 €/train-km, except for the Öresund connection, which corresponds to a section with a special charging system.

- Crossing a maritime border (French-English border through the Channel tunnel, German-Danish border through the Rodby ferry, and Danish-Swedish border through the Öresund connection) involves differences in infrastructure charges higher than 10 €/train-km.

- Borders between Eastern European countries (border between Poland and Czech Republic) have low differences in infrastructure charges (lower than 1 €/train-km).

- All Austrian (studied) borders (Austria – Czech Republic, Austria – Slovak Republic, Austria – Italy, Austria – Switzerland, Austria – Germany) present differences in infrastructure charges below 2 €/train-km.

- Differences in charges in the Italian-Swiss border (Chiasso) are about 5-10 €/train-km.

- The difference in charges in the Belgian-Luxembourg border is close to 40 €/train-km.

The first thing to be noticed is that the "gaps" in infrastructure charges can be considered rather high, since in some cases their value is as high as or even higher than the average charge of the link. This translates into important differences in the distribution of the charge along an international corridor, as we have seen in **table A9.1**.

In order to try to explain the value of these "gaps" in infrastructure charges, as well as the differences in infrastructure charges indexes along international links, the following aspects will be subsequently raised:

- Charging philosophies (marginal cost, full cost) and cost recovery rates:
    - Type of infrastructure and consideration of construction costs by pricing systems
    - Consideration of the commercial position of the market

- Structure of charges (linear tariff, two-part tariff)

TABLE A9.4 CHARACTERISTICS OF THE BORDER POINTS ANALYSED

Border	Border point	Ch. Philos.*	Charging structure*	Cost recovery rate*	Type of line
DK - SE	Öresund	MC+ / MC+	L / L	20% / 5%	NL / NL
SK - AT	Devínska Nová Ves štátna hranica-Staatsgrenze N. Marchegg	? / MC+	L / L	25% to 50% / 27%	CL / CL
FR - BE	Wannehain Frontière/Esplechin Frontière	MC+ / FC-	TP / L	63% / 20%	NL / NL
SL - IT	Sežana d.m./Villa Oficina	FC / FC- (1)	L / TP	13% / 16%	CL / CL
FR - CH	La Plaine	MC+ / MC+	TP / L	63% / 30%	CL / CL
FR - DE	Strabourg-Port-du-Rhin/Kehl Grenze	MC+ / FC-	TP / L	63% / 60%(2)	CL / CL
	Stiring-Wendel- Saarbrücken Grenze	MC+ / FC-	TP / L	63% / 60%(2)	CL / CL
NL - BE	Essen-Grens	MC / FC-	L / L	12% / 20%	NL / NL
AT - DE	Passau Grenze/State Border N. Pyret	MC+ / FC-	L / L	27% / 60%(2)	CL / CL
	Kufstein Grenze - State Border N. Kufstein	MC+ / FC-	L / L	27% / 60%(2)	CL / CL
	State Border N. Lochau-Hörbranz – Lindau	MC+ / FC-	L / L	27% / 60%(2)	CL / CL
	Salzburg Grenze	MC+ / FC-	L / L	27% / 60%(2)	CL / CL
BE - DE	Hergenrath (Frontière)/Aachen Süd Grenze	FC- / FC-	L / L	20% / 60%(2)	CL / CL
UK - FR	Eurotunnel	MC+ / MC+	TP(3) / TP	50 à 100% / 63%	NL / NL
CZ – AT	Břeclav St. Hr. – State Border N. Bernhardsthal	MC+ / MC+	L /L	60% / 27%	CL / CL
NL – DE	Bad Bentheim Grenze	MC / FC-	L / L	12% / 60%(2)	CL / CL
PL – DE	Frankfurt (Oder) Grenze – Kunowice(GR)	FC / FC-	L / L	91,4% / 60%(2)	CL / CL
CZ – DE	Cheb st. Hr./Schirnding Grenze	MC+ / FC-	L / L	60% / 60%(2)	CL / CL
	Dolní Zleb (st. Hr)	MC+ / FC-	L / L	60% / 60%(2)	CL / CL
SE – NO	Kornsjö	MC+ / ?	L / L	20% / 0,82%	CL / CL
	Charlottenberg	MC+ / ?	L / L	20% / 0,82%	UL / CL
PT – ES	PK 428,5 (Frontera)	MC / MC+	L / TP	20% / ?	CL / CL
ES – FR	Hendaye	MC+ / MC+	TP / TP	? / 63%	CL / CL
	Cerbère	MC+ / MC+	TP / TP	? / 63%	CL / CL
PL – CZ	Zebrzydowice (GR)	FC / MC+	L / L	91,4% / 60%	CL / CL
DK – DE	Puttgarden – Rodby	MC+ / FC-	L / L	20% / 60%(2)	CL / CL
IT – CH	Chiasso	FC- (1) / MC+	TP / L	16% / 30%	CL / CL
CH – DE	Basel St. Johann – Weil am Rhein	MC+ / FC-	L / L	30% / 60%(2)	CL / CL
AT – IT	State Border N. Brenner	MC+ / FC- (1)	L / TP	27% / 16%	CL / NL
CH – AT	St. Margrethen (State Border)	MC+ / MC+	L / L	30% / 27%	CL / CL
	State Border N. Charnitz (Buchs)	MC+ / MC+	L / L	30% / 27%	CL / CL
	Buchs SG – State Border N. Schaan-Vaduz				
LU – BE	Aubange Frontière – Rondange Frontière	? / FC-	? / L	¿ / 20%	CL / CL
LU – FR	Apach (Moselle) Frontière	? / MC+	? / TP	¿ / 63%	CL / CL

Border	Border point	Ch. Philos.*	Charging structure*	Cost recovery rate*	Type of line
LU – DE	Igel Grenze	? / FC-	? / L	¿ / 60%[2]	CL / CL
IT – FR	Modane	FC-[1] / MC+	TP / TP	16% / 63%	CL / CL

Remarks:

* The charging philosophy, the tariff applied and the cost recovery rate of the country correspond to those applied in the whole of the country and all the market segments, according to CEMT (2005).

(1) Traffic management only

(2) Objective: 100%

(3) Passenger trains

Abbreviations:

- Concerning the charging philosophy: MC: Marginal cost; MC+: Marginal cost with mark ups; FC: Full cost; FC-: Full cost recovery after subsidies
- Concerning the charging structure: L: Linear tariff; TP: Two-part tariff
- Concerning the type of line: NL: New line; UL: Upgraded line; CL: Conventional line

Some of the data needed to carry out this analysis has been summarised in **table A9.4**, which characterises the border points in terms of charging philosophy, charging structure, cost recovery rate and type of infrastructure for both sides of the border.

A9.2.1. Charging philosophies and cost recovery rates: who finances an international link?

The consideration of different charging principles or philosophies over an international corridor may lead to a dilemma; indeed, in an international corridor some problems may arise from the consideration of the different charging philosophies in two neighbouring countries. For instance, if one country charges marginal cost (MC) and the neighbouring one charges full cost after subsidies (FC-), for a given international common link the State budget of the first country will be financing a greater part of the social and economical benefits of this international link. In addition to this, the extent to which investment costs (and other infrastructure costs) are recovered by infrastructure charges and the consideration of the commercial position or the ability to pay by charging systems, will also lead to one State contributing to a higher extent than a neighbouring one to finance an international link.

In **table A9.5** the different border points analysed have been grouped according to the gap in the level of infrastructure charges, indicating in each case the type of infrastructure composing the line on both sides of the border (new line and conventional line).

According to the information contained in **table A9.5**, most border sections are built with conventional infrastructure. If we take into consideration that, as presented in section 4.4, conventional lines capital costs are mainly sunk, it can be affirmed that the "gaps" in rail infrastructure charges in border sections are, in principle, not due to differences in the consideration of investment costs by pricing structures between two neighbouring countries.

TABLE A9.5 TYPE OF RAIL INFRASTRUCTURE CHARGE FOUND IN THE BORDERS GROUPED ACCORDING TO THE "GAP" OBSERVED IN THE LEVEL OF CHARGE

[0;1[	[1;2[	[2;3[	[3;5[	[5;10[	[10;∞[
(2) SK – AT	(4) SL – IT	(6a,b) FR – DE	(3) FR – BE	(16) PT – ES	(1) DK – SE
(5) FR – CH	(8a,d) AT – DE	(9) BE – DE		(20) IT – CH	(10) UK – FR
(7) NL – BE	(18) PL – CZ	(12) NL – DE			(19) DK – DE
(8b,c) AT-DE	(22) AT – IT	(14a,b) CZ – DE			(24) LU – BE
(11) CZ – AT	(23b) CH – AT	(17a,b) ES – FR			
(13) PL – DE		(21) CH – DE			
(15) SE – NO*		(26) LU – DE			
(23a) CH – AT					
(25) LU – FR					
(27) IT – FR					

<u>Remark</u>:

[0;0[: value of "gap" in rail infrastructure charges in the border points, expressed in €/train-km.
(0): border point considered according to the numeration in **table A9.2**.

* Regarding the two border points between Sweden and Norway, the one in Körnsjö is built with conventional line on both sides of the border, whilst the one in Charlottenberg is composed of upgraded and conventional line on the Swedish and Norwegian sides, respectively.

🟧 Conventional line
🟨 New line

A few borders are exceptions to that tendency (conventional infrastructure at a border section). In them, the infrastructure corresponds to a new line on both sides of the border or to a mixture of infrastructure. Consequently, the consideration of construction costs by charging systems may have an effect on the amount of charges and therefore, on the "gaps" in charges at border points. These exceptions are found in:

- *Big civil works linking different countries*: the Channel Tunnel, linking the United Kingdom and France, and the Öresund, linking Denmark and Sweden.

- *International high speed links, served by "international" operators*: Dutch – Belgian border and French – Belgian border, both served by Thalys[31], and

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[31] Thalys is a joint service offered by the Belgian, French, Dutch and German railways. It provides commercial passenger rail transport services on behalf of SNCB, SNCF and DB to the following destinations: Paris, Brussels, Amsterdam and Cologne (www.thalys.com/fr/en/).

English– French border, served by Eurostar[32].

- *Two special cases, where the infrastructure has a different nature on one side and on the other side of the border*: Austrian – Italian border and one of the border points between Sweden and Norway (Charlottenberg).

With regard to big civil works linking different countries, namely the Channel Tunnel and the Öresund works, the great "gaps" in charges (more than 10 €/train-km -see **table A9.3**-) are due to the important construction costs (see **table A9.6**) and the charging schemes aiming at recovering them totally, in the case of the Channel Tunnel, or partially, in the case of the Öresund connection.

TABLE A9.6 CHARACTERISTICS OF THE SECTIONS WITH SPECIAL CHARGING SYSTEMS (BIG CIVIL WORKS)

Infrastructure	Characteristics	Max. Speed (km/h)	Construction cost	Traffic (millions/year)
Channel Tunnel	Tunnel	160	14.680,13 millions €(1) (293,60 millions €/km)	7,5(2)
Öresund connection	Tunnel + artificial island + bridge	200	1.565,68 millions € (41,20 millions €/km)	
Storebælt rail link	Two bridges + tunnel	180	2.870,00 millions €(3) (160,00 millions €/km)	7,3 (4)

Remarks:
(1) This cost includes the financing with shareholder funds and bank loans (Eurotunnel, 2006).
(2) Eurostar rail traffic 2005.
(3) 1998 prices.
(4) Rail traffic in 2004.

Since the Channel Tunnel is privately financed, its construction cost (€14.680,13 million[33]) should be wholly recovered through the payment of infrastructure charges by railway operators using it. As a result of this, high infrastructure charges are imposed by Eurotunnel. According to Rail Professional (2008), these high charges result in Eurostar UK Ltd (which jointly owns the train business with the national railways of France and Belgium) reporting losses of about £100 million a year as a result of these.

On the other hand, the gap in the charge index in the Öresund connection is also

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[32] Eurostar is a high speed rail service directly linking the UK to France and Belgium via the Channel Tunnel (www.eurostar.com).

[33] This cost includes the financing with shareholder funds and bank loans (Eurotunnel, 2006).

remarkable, but lower than the one registered in the Channel Tunnel. In this case, the investment costs are not privately financed but they are met by the Danish and the Swedish States, as well as the Danish IM, which finances part of the construction costs charging 1.781 DKK per passenger every train going through the Öresund connection. The Swedish IM (Baneverket), on the contrary, does not charge passenger trains taking the Öresund connection. Therefore, the Swedish State would be financing the big civil work to a higher extent than the Danish State.

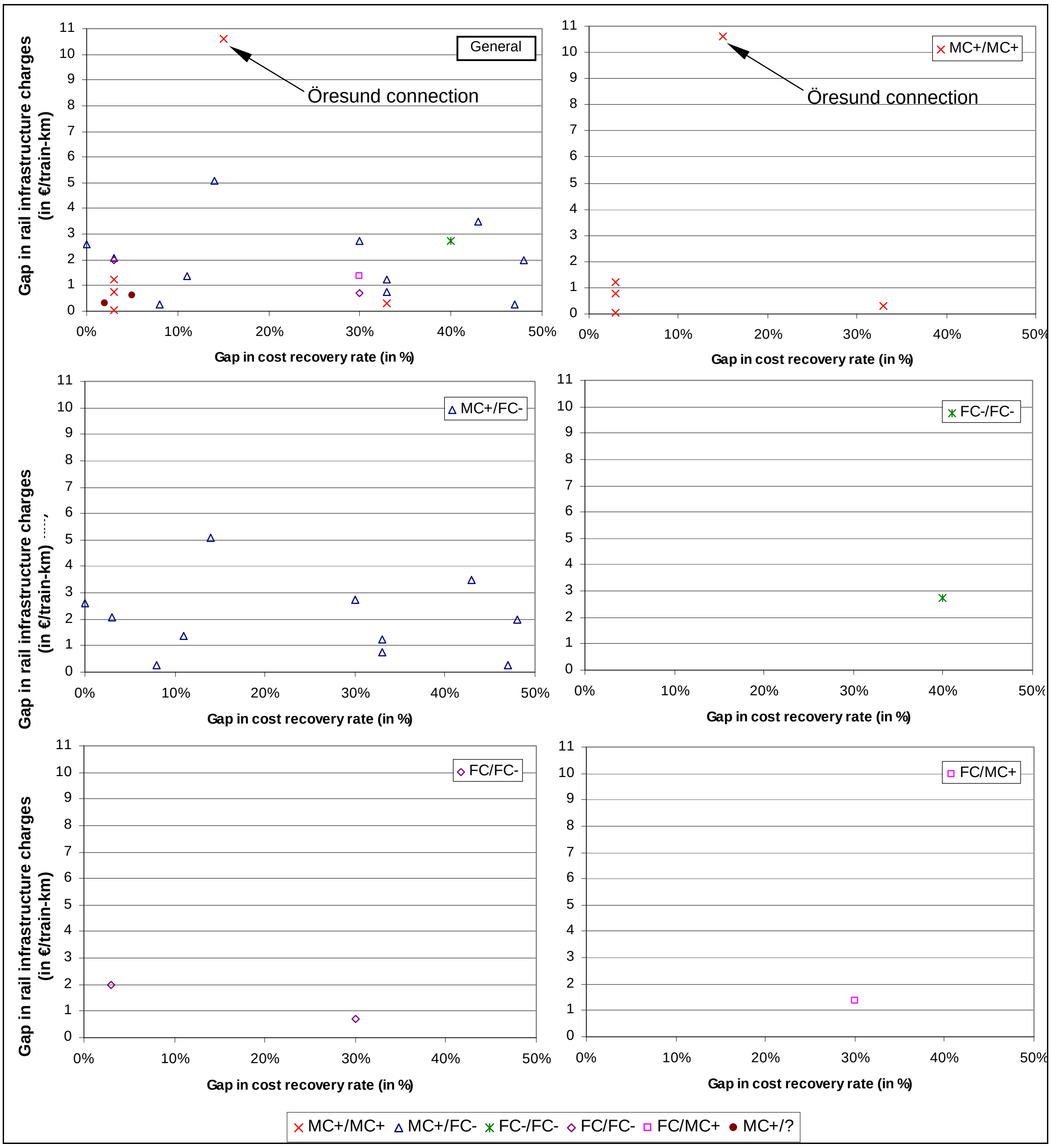
Concerning the case of international high speed links served by "international" operators, the "gap" in charges at the French-Belgian border is comprised between 3 and 5 €/train-km, while the one at the Dutch-Belgian border is lower than 1 €/train-km. In these three countries, the French IM partly covers investment costs. On the contrary, the Dutch IM does not recover investment costs through infrastructure charges and the Belgian IM's pricing system covers the key drivers relating to marginal cost as well as other parameters that compose the social marginal cost of running a train. This information on recovery of investment costs could explain why the "gap" is higher in the French-Belgian border (where only one of the border countries partly recovers investment costs through infrastructure charges) than in the Dutch-Belgian border (where none of the border countries have charging systems aiming at recovering investment costs).

Finally, with regard to the two special cases where the infrastructure has a different nature on one side and on the other side of the border (see **table A9.5**, in the case of the Swedish-Norwegian border point, the "gap" below 1 €/train-km is the result of the low cost recovery rates in both countries (less than 5%) and the non recovery of investment costs through infrastructure charges. In the case of the Austrian-Italian border point, only the Austrian IM recovers part of the investment costs. Therefore, in this case, the consideration of investment costs by the charging systems does not explain the gap in infrastructure charge at the Austrian-Italian border point.

In order to assess whether cost recovery rates could explain the order of magnitude of these gaps in infrastructure charges at the borders, especially in the cases where border sections are composed by conventional infrastructure on both sides of the border, **figure A9.5** was produced. This figure shows the value of the border gaps in rail infrastructure charges according to the gap in the cost recovery rate (of total infrastructure expenditures, loans and subsidies included) and the infrastructure principle on each side of a border.

It is to be noticed that higher "gaps" in cost recovery rates do not lead to higher gaps in rail infrastructure charges as it would seem reasonable to expect. This fact could be explained by the following reasons:

FIGURE A9.5 VALUE OF THE "GAP" IN RAIL INFRASTRUCTURE CHARGES CONTINGENT ON THE PRICING PRINCIPLE AND THE COST RECOVERY RATE



- The cost recovery rates used for the analysis correspond to national cost recovery rates for 2004-2005 as published by CEMT (2005). According to Steer Davies Gleave (2006), "subsidies and grants to IMs are usually given in lump sums, so it is difficult to identify the amount of infrastructure subsidy that is applied to each route. In addition, Crozet (2007), when commenting on the level of rail charges, says that "globally infrastructure charges are getting closer to costs, but this is not the case when considering different parts of the network. While on a large part of the network, the charge is below marginal cost, on the busiest high speed lines is far above full cost". Therefore, the value of the cost recovery rate for a given country could be different between the different types of services (high speed services, freight services, regional services, etc.) or different routes, according to the amount of infrastructure subsidy applied to each link. This fact would explain why higher "gaps" in (average) cost recovery rates do not lead (according to the data available) to higher "gaps" in rail infrastructure charges for high speed or high performance services.

- A particular case of the aforementioned reason (cost recovery rates used for the analysis not homogeneously valid across all type of services) would be the application of cross-subsidies between freight and passenger transport or the application of a full cost recovery philosophy for freight services and a marginal cost charging for passenger services. This could be the case of the Polish – German and the Polish – Czech Republic borders, where the "gap" in cost recovery rate is around 30% but the "gaps" in rail infrastructure charges amount to 0,7 and 1,36 €/train-km respectively. According to data published by CEMT (2005), average access charges for freight trains are almost three times the average charge for passenger trains; and such differences can only be explained by cross-subsidisation or the application of different pricing philosophies across different types of traffic (passenger, freight).

- Cost recovery rates may vary from one year to another. Therefore, there is the possibility that the infrastructure charges calculated in this study (valid for 2006) do not lead to the cost recovery rates used for the analysis (valid for the year 2004-2005). For instance, according to Infrabel, the current cost recovery is no longer 20%[34]. Nevertheless, it is unlikely that great variations in cost recovery rates occur from one year to another.

- Even with the assumption that the cost recovery rates available (CEMT, 2005) apply homogeneously to all the network and type of services, the values of cost recovery rates are not comparable among countries, since the total infrastructure expenditures (loans and subsidies included) differ from one country to another. As Nash indicated in Nash (2005), ground conditions, wage levels and types of traffic give rise to genuine differences in cost among European countries. Therefore, a 30% cost recovery rate does not necessarily correspond to the same amount of money in two different countries. **Figure A9.6** illustrates this same fact for maintenance and renewal costs in different European railway networks.

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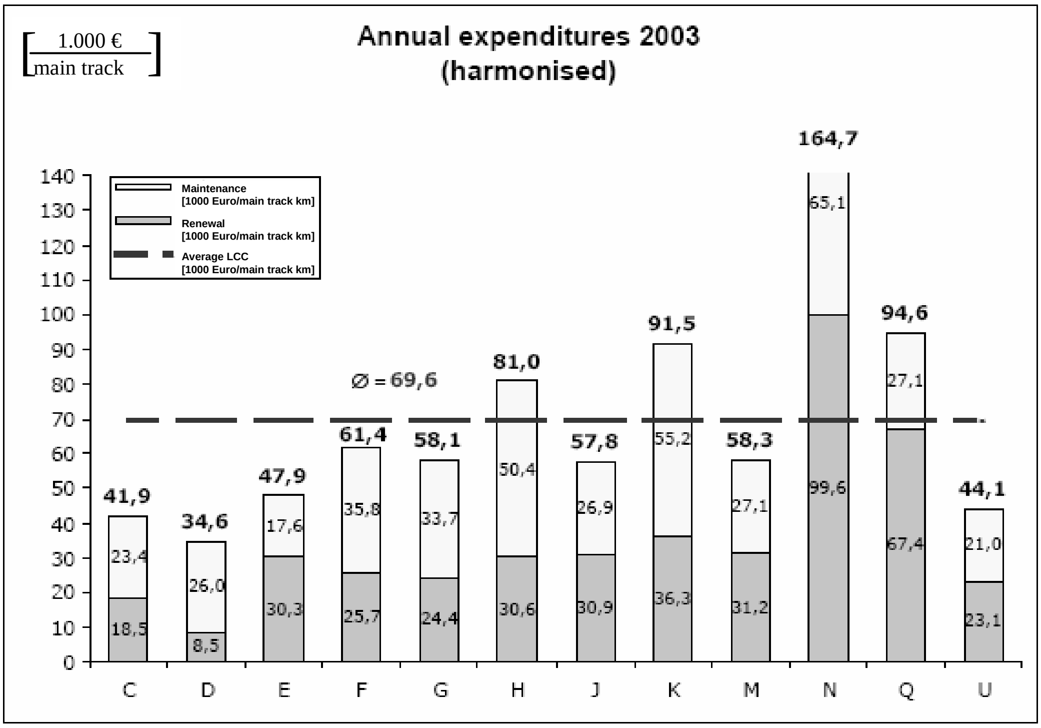
[34] Information obtained from Infrabel's Network Access Division.

Last but not least, the consideration of the commercial position and the ability to pay of the market for high speed links has introduced an added complexity to the calculation procedure, materialised in the definition of different time periods and categories of infrastructure.

FIGURE A9.6 MAINTENANCE AND RENEWAL COSTS PER KILOMETRE OF MAIN TRACK AND YEAR

Source: Dalton (2005)



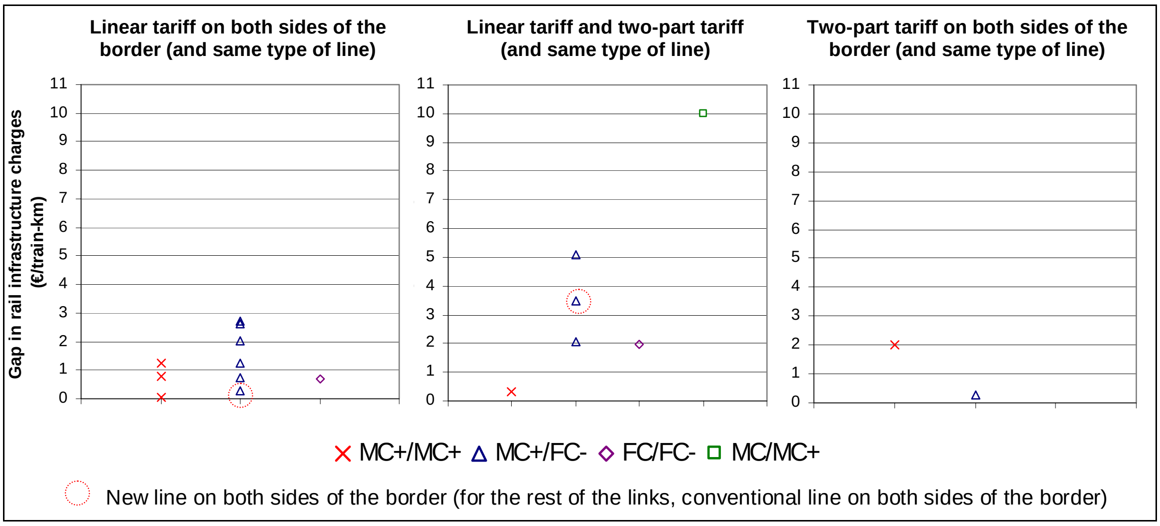
With regard to the categorisation of the infrastructure, rail infrastructure is commonly classified into three different categories: conventional lines, upgraded lines and new lines. Nevertheless, in terms of infrastructure charging, IMs have divided their infrastructure into other categories. A detailed analysis of the network statements of the railway networks of the geographical framework analysed shows that, for instance, Portugal has defined 17 categories; Germany and France 12; Belgium, 7; Austria, 6; Spain, Italy and the Slovak Republic, 4; Latvia and the Czech Republic, 3; Slovenia, Sweden and Switzerland, 2. Each category is usually only valid in one country and is associated to a particular charge. This fact adds a complexity to the rail infrastructure charges calculation procedure. This complexity leads in some cases to the need to divide a given link, for which the infrastructure charge has to be calculated, into several segments (even more than 200). This complexity can be interpreted as a new barrier for HP passenger services.

The definition of timetable periods adds a new border as well, since it varies from one country to another.

A9.2.2. Combination of linear tariffs with two-part tariffs: an economic border

In 2006, the IMPRINT-NET Expert Group on rail transport (IMPRINT-NET, 2006) pointed out that differences in the structure of charges could be important in some cases. As an example, they mentioned that "whilst differences in structure between different single part tariffs might be of relatively little significance, the difference between a two-part tariff and a linear tariff is likely to be significant, for instance in its impact on smaller operators and on international operators".

FIGURE A9.7 "GAP" (IN €/TRAIN-KM) IN THE BORDERS, ACCORDING TO THE CHARGING STRUCTURE (LINEAR TARIFF, TWO-PARTS TARIFF) AND THE CHARGING PRINCIPLE APPLIED ON EACH SIDE OF THE BORDER



In this section, the difference between a two-part tariff and a linear tariff was quantified in terms of "gap" in infrastructure charge in different border points and compared to the results obtained with linear tariffs on both sides of a border, as well as with two-part tariffs on both sides of a border. **Figure A9.7** presents the results obtained, distinguishing at the same time by type of charging principle applied on each side of the border. The "gaps" in charges are expressed in euros per train-km and only border points where the type of infrastructure is the same on both sides of the border are represented (the Öresund connection and the Channel Tunnel were not considered for this analysis because of their particularities). Regarding charges resulting from a two-part tariff charging structure, the fixed part, if not specified in €/train-km in the Network Statement, has been wholly attributed to the border section, since it will be paid by railway operators when they enter the network, regardless of the distance run along it.

According to the results obtained it would seem that the implementation of a linear tariff on one side of the border and a two-part tariff on the other side of the border leads to higher “gaps” in charges than if the charging structure was linear on both sides of the border there where countries charge according to MC+ and FC-. This could be interpreted as the application of a two-part tariff in one country and a linear tariff in a border country introducing an economic barrier for HS railways, indirectly derived from the mark ups allowed by linear and two-part tariffs.

A9.3. COMMENTS ON THE CONSEQUENCES OF CURRENT RAIL INFRASTRUCTURE CHARGES FOR INTERNATIONAL SERVICES RUNNING ON THE EUROPEAN HIGH SPEED NETWORK

The European Rail Infrastructure Managers –EIM– had already expressed their concerns (EC, 2005) about the heterogeneity of the current rail infrastructure pricing systems in the Member states having negative repercussions on the organisation of international rail transport services as well as on their competitiveness. This statement is based on the fact that for a RU to be competitive, it must be able to plan its business, which is currently of great complexity in the European railway framework due to the heterogeneity of the infrastructure charging systems. In addition to the calculation complexity, the variability of those pricing systems can be seen as a time barrier. IMs and consequently RUs are faced with a certain instability (with very few exceptions): on the one hand, financing is not stable because it depends on how annual State budgets are structured; on the other hand, the structure of national rail infrastructure pricing systems are reviewed rather frequently (new elements are considered while others are eliminated). Therefore, planning becomes a very complicated task for RUs.

In this annex, those international barriers have been analysed focusing on the “gaps” in charges at border points resulting from the application of different pricing schemes on one side and the other side of a border. Calculations have shown rather high “gaps”, since in some cases their value is as high as the average charge of the link or even higher.

An attempt to classify the amount of those “gaps” according to the charging philosophies and cost recovery rates have shown that, at border points, the differences in charges in two neighbouring sections are mainly due to a different consideration of the commercial position of the market and, therefore, the ability to pay. This is considered by means of the definition of different categories of infrastructure in terms of infrastructure charging and of different timetable periods, which are, on the whole, particular to each single country. The unavailability of cost recovery rates for high speed links has not allowed to correctly analyse the influence that the use of different charging principles and cost recovery rates has on the value of the “gaps” in two border sections.

Finally, concerning the charging structure (linear tariffs and two-part tariffs), Nash (2004) and CEMT (2005) had previously reported on the barrier that the presence of two-part tariffs could mean to international services, i.e. to an operator from another country seeking a path, since it would be operating on a small scale in the country concerned. The calculations carried out in this annex for international high performance links show that changing from a linear tariff to a two-part tariff leads to higher gaps in charges (between two border sections) than if the charging structure were linear on both sides of the border there where countries charge according to MC+ and FC-, that is to say, where mark ups above marginal costs are applied or where the level of charges is set to collect the difference between state compensation and full financial cost.

ANNEX A10

EVOLUTION OF THE LEVEL OF RAIL INFRASTRUCTURE CHARGES FOR EUROPEAN HIGH SPEED LINKS

A10.1. EVOLUTION OF THE LEVEL OF RAIL INFRASTRUCTURE CHARGES FOR FRENCH HIGH SPEED LINKS

In **figure A10.1** the evolution of the level of charges of the different additive factors composing the final charge has been summarised.

With regard to access charges (DA, *Droit d'accès*), it is difficult to establish their evolution from 2005 onwards, since the unit in which they are charged changed from €/train-km/month to €/train-km. However, it can be said that in 2007, access charges for all high speed lines were raised, whilst the ones applied to the rest of the lines were kept constant.

Concerning train-path reservation charges (DRS, *Droit de réservation du sillon*), they experienced several changes in the period 2001-2008, increasing their value for high speed lines year after year for all time periods (off-peak, normal and peak hours). For the rest of the lines, changes introduced from 2003 onwards implied increases in the level of charges.

With regard to reservation charges for stopping at stations (DRAG, *Droit de réservation d'arrêt en gare*), values for suburban lines with high traffic (A) at off-peak hours have undergone several increases and reductions, until being equalled to zero, as for the rest of line categories. In normal and peak hours, values were substantially modified in 2004 and since then, only high speed lines and suburban lines with high levels of traffic have seen increases in the level of charges.

Finally, the running charge (DC, *Droit de circulation*), which is the one approximately linked to the marginal costs for using the infrastructure, has been substantially raised from 2001 to 2008 for national passenger trains (from 0,235 €/train-km in 2001 to 1,400 €/train-km in 2008).

FIGURE A10.1 EVOLUTION OF THE UNIT VALUES OF THE FRENCH INFRASTRUCTURE CHARGING SYSTEM (2001-2008)

Source: Own from data collected by Muñoz (2008)

Components of the formula *(units)*	Categories

	Year	Suburban lines		Main intercity lines				High speed lines						Other lines
		A	B	C	C*	D	D*	N1	N2	N2*	N3	N3*	N4	E
DA - *In €/train-km/month from 2001 to 2005* - *In €/train-km from 2006 on*	**2001**	1.761,440		39,970				6.783,980	6.783,980	-	6.783,980	-	-	0,000
	2002	365,880	365,880	3,050	3,050	0,000	0,000	5.294,550	5.294,550	3.384,370	5.294,550	3.384,370	-	
	2003	373,124	373,124	3,110	3,110	0,000	0,000	4.475,912	4.475,912	4.475,912	4.475,912	4.475,912	-	0,000
	2004	773,124	373,124	3,110	3,110	0,000	0,000	4.475,912	4.475,912	4.475,912	4.475,912	4.475,912	-	0,000
	2005	773,124	373,124	3,110	3,110	0,000	0,000	4.475,912	4.475,912	4.475,912	4.475,912	4.475,912	-	0,000
	2006	0,015	0,015	0,015	0,015	0,000	0,000	0,946	0,946	0,946	0,946	0,946	-	0,000
	2007	0,015	0,015	0,015	0,015	0,000	0,000	1,030	1,030	1,030	1,030	1,030	1,030	0,000
	2008	0,015	0,015	0,015	0,015	0,000	0,000	1,030	1,030	1,030	1,030	1,030	1,030	0,000

	Time period	Year	Suburban lines		Main intercity lines				High-speed lines						Other lines
			A	B	C	C*	D	D*	N1	N2	N2*	N3	N3*	N4	E
DRS *(€ / km)*	Off-peak hour	**2001**	3,030		0,340				4,480	1,050	1,050	0,750	0,750	-	0,000
		2002	1,520	0,610	0,000	0,000	0,000	0,000	4,570	1,070	1,070	0,760	0,760	-	0,000
		2003	1,550	0,622	0,000	0,000	0,000	0,000	4,813	1,122	1,122	0,806	0,806	-	0,000
		2004	1,550	0,622	0,010	0,010	0,010	0,010	4,800	1,142	1,142	0,816	0,816	-	0,000
		2005	1,550	0,622	0,380	0,380	0,010	0,010	5,187	1,213	1,213	0,867	0,867	-	0,000
		2006	1,550	0,650	0,650	0,650	0,010	0,010	5,366	1,255	1,255	0,896	0,896	-	0,000
		2007	1,850	0,650	0,650	0,650	0,010	0,010	5,408	1,264	1,264	0,904	0,904	0,700	0,000
		2008	1,850	0,750	0,750	0,750	0,010	0,010	5,600	1,310	1,310	0,940	0,940	0,890	0,000
	Normal hour	**2001**	6,660		0,340				9,270	2,180	2,180	1,570	1,570	-	0,000
		2002	4,880	1,220	0,080	0,080	0,000	0,000	9,300	2,290	2,290	1,600	1,600	-	0,000
		2003	4,977	1,244	0,082	0,082	0,000	0,000	9,780	2,407	2,407	1,683	1,683	-	0,000
		2004	4,970	1,244	0,130	0,130	0,050	0,050	9,843	2,700	2,700	1,713	1,713	-	0,005
		2005	4,970	1,244	0,380	0,380	0,050	0,050	10,435	2,864	2,864	1,822	1,822	-	0,005
		2006	4,970	1,244	0,650	0,650	0,050	0,050	10,739	2,949	2,949	1,894	1,894	-	0,005
		2007	5,034	1,250	0,650	0,650	0,050	0,050	11,103	3,510	3,510	1,905	1,905	1,700	0,005
		2008	5,034	1,450	0,750	0,750	0,051	0,051	11,400	5,100	5,100	2,610	2,610	2,490	0,005
	Peak hour	**2001**	15,140		0,340				10,760	4,480	4,480	2,990	2,990	-	0,000
		2002	14,030	2,440	0,080	0,080	0,000	0,000	10,980	4,570	4,570	3,050	3,050	-	0,000
		2003	14,308	2,488	0,082	0,082	0,000	0,000	11,544	4,813	4,813	3,202	3,202	-	0,000
		2004	14,300	3,280	1,250	1,250	0,050	0,050	11,710	5,100	5,100	3,250	3.250	-	0,005
		2005	14,300	3,280	1,250	1,250	0,050	0,050	12,437	5,426	5,426	3,458	3,458	-	0,005
		2006	14,300	3,280	1,250	1,250	0,050	0,050	12,870	5,586	5,586	3,565	3,565	-	0,005
		2007	14,500	3,280	1,500	1,500	0,050	0,050	13,310	6,320	6,320	3,604	3,604	2,980	0,005
		2008	14,560	3,280	1,550	1,550	0,051	0,051	13,900	7,300	7,300	4,400	4,400	4,290	0,005

	Time period	Year	Suburban lines		Main intercity lines				High speed lines						Other lines
			A	B	C	C*	E	D*	N1	N2	N2*	N3	N3*	N4	E
DRAG (€/train-km)	Off-peak hour	**2001**													
		2002	21,950	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	-	0,000
		2003	22,385	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	-	0,000
		2004	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	-	0,000
		2005	5,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	-	0,000
		2006	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	-	0,000
		2007	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
		2008	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
	Normal hour	**2001**													
		2002	21,950	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	-	0,000
		2003	22,385	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	-	0,000
		2004	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	-	5,500
		2005	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	5,500	-	5,500
		2006	7,200	5,500	5,500	5,500	5,500	5,500	7,200	5,500	5,500	5,500	5,500	-	5,500
		2007	8,000	5,500	5,500	5,500	5,500	5,500	8,000	5,500	5,500	5,500	5,500	5,500	5,500
		2008	8,895	5,500	5,500	5,500	5,500	5,500	8,895	5,500	5,500	5,500	5,500	5,500	5,500
	Peak hour	**2001**													
		2002	21,950	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	-	0,000
		2003	22,385	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	-	0,000
		2004	21,200	21,200	21,200	21,200	21,200	21,200	21,200	21,200	21,200	21,200	21,200	-	10,000
		2005	24,350	21,200	21,200	21,200	21,200	21,200	24,350	21,200	21,200	21,200	21,200	-	10,000
		2006	24,350	21,200	21,200	21,200	21,200	21,200	24,350	21,200	21,200	21,200	21,200	-	10,000
		2007	25,000	21,200	21,200	21,200	21,200	21,200	25,000	21,200	21,200	21,200	21,200	21,200	10,000
		2008	25,000	21,200	21,200	21,200	21,200	21,200	25,000	21,200	21,200	21,200	21,200	21,200	10,000

	Year	Suburban lines		Main intercity lines				High speed lines						Other lines
		A	B	C	C*	D	D*	N1	N2	N2*	N3	N3*	N4	E
DC National Passengers trains *(€/train-km)*	**2001**	0,235												
	2002	0,790												
	2003	0,806												
	2004	0,806												
	2005	0,806												
	2006	0,944												
	2007	1,200												
	2008	1,400												

🟩 Decrease with regard to previous year 🟧 Increase with regard to previous year ☐ Unchanged with regard to previous year

DA: Access charge DRS: Train-path reservation charge DRAG: Reservation charge for stopping at a station DC: Running charge

A10.2. EVOLUTION OF THE LEVEL OF RAIL INFRASTRUCTURE CHARGES FOR SPANISH HIGH SPEED LINKS

In Spain, the structure and level of charges are defined in MFOM (2003), for the years 2003-2005, and MFOM (2005), for 2006 to the present date. The charging structure and/or the units defined in each Decree of the Ministry of Fomento (MFOM) differ considerably from the other. Therefore, a comparison of the unit values in order to gauge the evolution of the level of charges is not possible (see **figure A10.2**).

FIGURE A10.2 EVOLUTION OF UNIT VALUES OF THE SPANISH INFRATRUCTURE CHARGING SYSTEM (2003-2008)
Source: Own from MFOM (2003, 2005)

Components of the formula *(units)*	Categories

Infrastructure charge for the use of railway lines		Year	Level of traffic				
			N1	N2.A	N2.B	N3.A	N3.B
	Access tariff - Class A	2003-2005	6,59 €				
		2006-2008	60.000 €/year	150.000 €/year	330.000 €/year	690.000 €/year	1.410.000 €/year

	Line type	Time period	Year	Type of service			
				V1	V2	M	P
Capacity reservation tariff – Class B	A1	Peak	2003-2005	1,10 €/train-km * (1 + 0,25*$\lvert 540/V_t – 540/V_n \rvert$)			
			2006-2008	3,40 €/train-km	2,10 €/train-km	-	0,84 €/train-km
		Normal	2003-2005	1,10 €/train-km * (1 + 0,25*$\lvert 540/V_t – 540/V_n \rvert$)			
			2006-2008	2,20 €/train-km	1,05 €/train-km	-	0,84 €/train-km
		Off-peak	2003-2005	1,10 €/train-km * (1 + 0,25*$\lvert 540/V_t – 540/V_n \rvert$)			
			2006-2008	0,75 €/train-km	0,70 €/train-km	-	0,84 €/train-km
	A2	Peak	2003-2005	1,10 €/train-km * (1 + 0,25*$\lvert 540/V_t – 540/V_n \rvert$)			
			2006-2008	3,30 €/train-km	2,00 €/train-km	-	0,75 €/train-km
		Normal	2003-2005	1,10 €/train-km * (1 + 0,25*$\lvert 540/V_t – 540/V_n \rvert$)			
			2006-2008	2,10 €/train-km	1,00 €/train-km	-	0,75 €/train-km
		Off-peak	2003-2005	1,10 €/train-km * (1 + 0,25*$\lvert 540/V_t – 540/V_n \rvert$)			
			2006-2008	0,70 €/train-km	0,65 €/train-km	-	0,75 €/train-km
	B1	Peak	2003-2005	1,10 €/train-km * (1 + 0,25*$\lvert 540/V_t – 540/V_n \rvert$)			
			2006-2008	2,80 €/train-km	0,50 €/train-km	0,30 €/train-km	0,06 €/train-km
		Normal	2003-2005	1,10 €/train-km * (1 + 0,25*$\lvert 540/V_t – 540/V_n \rvert$)			
			2006-2008	0,20 €/train-km	0,20 €/train-km	0,05 €/train-km	0,05 €/train-km
		Off-peak	2003-2005	1,10 €/train-km * (1 + 0,25*$\lvert 540/V_t – 540/V_n \rvert$)			
			2006-2008	-	0,10 €/train-km	0,05 €/train-km	0,06 €/train-km
	C1	Peak	2003-2005	1,10 €/train-km * (1 + 0,25*$\lvert 540/V_t – 540/V_n \rvert$)			
			2006-2008	-	0,20 €/train-km	0,30 €/train-km	-
		Normal	2003-2005	1,10 €/train-km * (1 + 0,25*$\lvert 540/V_t – 540/V_n \rvert$)			
			2006-2008	-	0,20 €/train-km	0,05 €/train-km	-
		Off-peak	2003-2005	1,10 €/train-km * (1 + 0,25*$\lvert 540/V_t – 540/V_n \rvert$)			
			2006-2008	-	0,10 €/train-km	0,05 €/train-km	-

	Line type	Year	Type of service			
			V1	V2	M	P
Operating tariff - Class C	A1	2003-2005	0,57 €/fictitious tones-km + 0,15 to 0,33 €/dynamic tones-km + 0,05 €/pantograph-km			
		2006-2008	2,00 €/train-km	0,75 €/train-km	-	-
	A2	2003-2005	0,57 €/fictitious tones-km + 0,15 to 0,33 €/dynamic tones-km + 0,05 €/pantograph-km			
		2006-2008	1,90 €/train-km	0,70 €/train-km	-	-
	B1	2003-2005	0,57 €/fictitious tones-km + 0,15 to 0,33 €/dynamic tones-km + 0,05 €/pantograph-km			
		2006-2008	0,60 €/train-km	0,06 €/train-km	0,06 €/train-km	-
	C1	2003-2005	0,57 €/fictitious tones-km + 0,15 to 0,33 €/dynamic tones-km + 0,05 €/pantograph-km			
		2006-2008	-	0,06 €/train-km	0,06 €/train-km	-

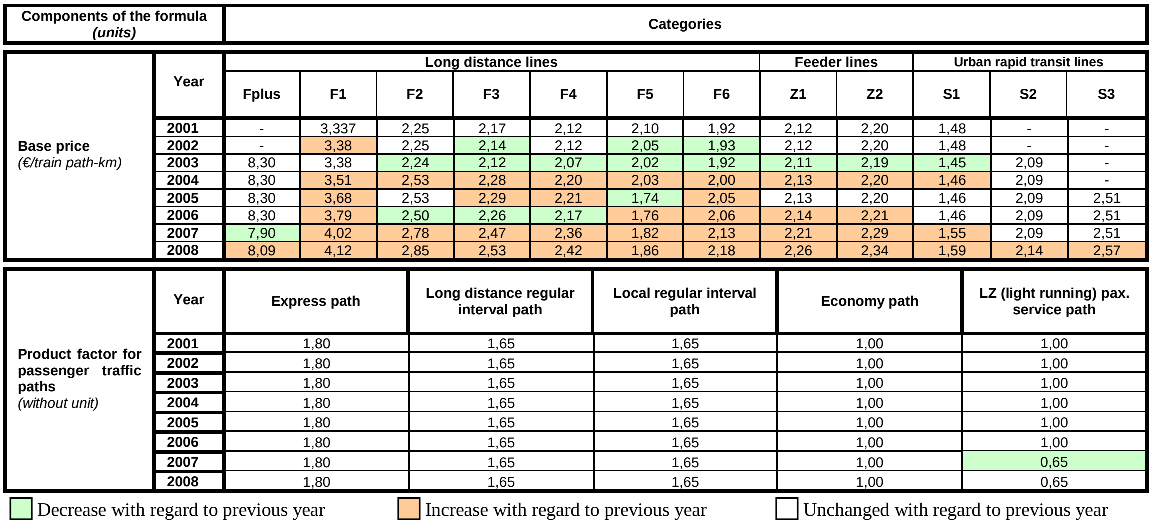
	Line type	Year	Time period		
			Peak	Normal	Off-peak
Traffic tariff - Class D	A1	2003-2005	In €/100 seats-km according to commercial speed and length of the journey		
		2006-2008	1,25 €/100 seats-km	0,70 €/100 seats-km	-
	A2	2003-2005	In €/100 seats-km according to commercial speed and length of the journey		
		2006-2008	1,20 €/100 seats-km	0,65 €/100 seats-km	-
	B1	2003-2005	In €/100 seats-km according to commercial speed and length of the journey		
		2006-2008	-	-	-
	C1	2003-2005	In €/100 seats-km according to commercial speed and length of the journey		
		2006-2008	-	-	-

	Class	Year	Distance			
			A	B	C	D
Tariff for station use - Class A	1st	2003-2005	13,17 € - 32,93 €			
		2006-2008	0,77 €/pax	0,43 €/pax	0,20 €/pax	0,08 €/pax
	2nd	2003-2005	Not specified			
		2006-2008	0,48 €/pax	0,30 €/pax	0,15 €/pax	0,06 €/pax
	3rd	2003-2005	Not specified			
		2006-2008	0,04 €/pax	0,04 €/pax	0,04 €/pax	0,02 €/pax

A10.3. EVOLUTION OF THE LEVEL OF RAIL INFRASTRUCTURE CHARGES FOR GERMAN HIGH SPEED LINKS

In Germany, where the charging system is structured as the product of several multiplicative factors, the base price has undergone several increases since 2004 (see **figure A10.3**). Exceptions to this tendency are urban rapid transit lines and the lines corresponding to category Fplus, which are, as presented in chapter 4, those of above-average importance in traffic terms and the ones that can be run at speeds above 280 km/h for the most part. For category Fplus, the base price value was already significantly high compared to the other lines in 2003 and in 2008 it still amounts to twice the value of the second category with highest charges (namely, F1). With regard to the product factor for passenger traffic paths, which is a multiplier of the base price and is determined according to the willingness to pay, no major changes have taken place.

FIGURE A10.3 EVOLUTION OF UNIT VALUES OF THE GERMAN INFRASTRUCTURE CHARGING SYSTEM (2001-2008)
Source: Own from data collected by Muñoz (2008)



Components of the formula *(units)*		Categories											
	Year	Long distance lines							Feeder lines		Urban rapid transit lines		
		Fplus	F1	F2	F3	F4	F5	F6	Z1	Z2	S1	S2	S3
Base price *(€/train path-km)*	**2001**	-	3,337	2,25	2,17	2,12	2,10	1,92	2,12	2,20	1,48	-	-
	2002	-	3,38	2,25	2,14	2,12	2,05	1,93	2,12	2,20	1,48	-	-
	2003	8,30	3,38	2,24	2,12	2,07	2,02	1,92	2,11	2,19	1,45	2,09	-
	2004	8,30	3,51	2,53	2,28	2,20	2,03	2,00	2,13	2,20	1,46	2,09	-
	2005	8,30	3,68	2,53	2,29	2,21	1,74	2,05	2,13	2,20	1,46	2,09	2,51
	2006	8,30	3,79	2,50	2,26	2,17	1,76	2,06	2,14	2,21	1,46	2,09	2,51
	2007	7,90	4,02	2,78	2,47	2,36	1,82	2,13	2,21	2,29	1,55	2,09	2,51
	2008	8,09	4,12	2,85	2,53	2,42	1,86	2,18	2,26	2,34	1,59	2,14	2,57

	Year	Express path	Long distance regular interval path	Local regular interval path	Economy path	LZ (light running) pax. service path
Product factor for passenger traffic paths *(without unit)*	**2001**	1,80	1,65	1,65	1,00	1,00
	2002	1,80	1,65	1,65	1,00	1,00
	2003	1,80	1,65	1,65	1,00	1,00
	2004	1,80	1,65	1,65	1,00	1,00
	2005	1,80	1,65	1,65	1,00	1,00
	2006	1,80	1,65	1,65	1,00	1,00
	2007	1,80	1,65	1,65	1,00	0,65
	2008	1,80	1,65	1,65	1,00	0,65

🟩 Decrease with regard to previous year 🟧 Increase with regard to previous year ☐ Unchanged with regard to previous year

A10.3. EVOLUTION OF THE LEVEL OF RAIL INFRASTRUCTURE CHARGES FOR ITALIAN HIGH SPEED LINKS

In Italy, the evolutions in the level of charges with regard to the ones applied in the year 2003 are established in the Decree of 15 July 2003 for the year 2004 and in Decree of 24 March 2005 for the year 2005. Values for 2006 are published in the corresponding Network Statement. The changes do not affect the pricing structure. They only stipulate an increase in the level of all unit values equal to the inflation rate expected by the Decree in question.