Optimal Infrastructure Charging in a Multi-Country Railway Corridor

Olga Ivanova[1]
Bruno Van Zeebroeck
Karel Spitaels

As a part of the RE-ORIENT research project we have studied the influence of the national policy regimes, related to railways infrastructure provision, upon the optimal choice of the infrastructure charges in the countries along the international railways corridor and the overall welfare of the countries. The international corridor studied is a corridor crossing 8 countries from Northern Europe to South-East Europe. We analyze the problem where the infrastructure managers of the countries along the railway corridor are in charge of the pricing of an access to their railways networks. The railways infrastructure is used by the railway operators to provide domestic and international, passenger and freight services.

1. Introduction

We study the influence of the national policy regimes, related to railways infrastructure pricing, upon the overall welfare of the countries. We analyze the problem where the infrastructure managers of the countries along the railways corridor are in charge of the pricing of an access to their railways networks. The railways infrastructure is used by the downstream firms to provide domestic and international, passenger and freight services.

The downstream firms originate from different EU countries and, hence, their operations are associated with different production costs and levels of the governmental subsidies. These firms operate under the oligopoly market structure.

The costs of building and maintaining national railways infrastructures can be financed either by governmental subsidies or through the user infrastructure charges. The degree of use of the governmental subsidies for the financing of the railways infrastructure determines the infrastructure provision regime in a particular EU country. The specific combination of different national regimes in the EU countries along the international railways corridor results in a certain national and overall welfare related to the railways sector.

The national welfare consists of the following main elements: domestic consumer surplus, surplus of the domestic downstream providers of railways services and subsidies for railways infrastructure provision. Based on the national welfare levels, it is possible to calculate the weighted total welfare of the countries along the railways transport corridor.

By optimizing the overall welfare measure of the corridor it is possible to determine the most welfare-efficient unified international infrastructure funding regime. This information will help to improve the present national legislative frameworks on the infrastructure funding in the countries along the transport corridor and, hence, optimize the efficiency of the transport operations on this international railways corridor.

[1] Corresponding author, e-mail: olga.ivanova@tmleuven.be, phone: +32 (16) 31 77 31

2. Overview of the railways infrastructure charging systems and structure of railway companies in Europe

Beginning in 1991 with Directive 91/440, the European Commission has pursued a policy of introducing competition in the provision of rail services and to achieve new entry by companies that would offer services across Europe (Nash, 2004). Detailed proposals on railway infrastructure charging emerged in Directive 2001/14, on allocation of railway infrastructure capacity and levying of charges. In summary the directive determines that charges must be based on costs directly incurred as a result of operation the train service. They may include:

- ✓ Scarcity, although where a section of track is defined as having a scarcity problem, the infrastructure manager must examine proposals to relieve that scarcity, and undertake them unless they are shown, on the basis of cost benefit analysis, not to be worthwhile.
- ✓ Environmental costs, but only where these are levied on other modes.
- ✓ Recovery of the cost of specific investments where these are worthwhile and could not otherwise be funded.
- ✓ Discounts but only where justified by lower costs; large operators may not use their market power to get discounts.
- ✓ Reservation charges for scarce capacity. These has to be paid whether or not capacity is used.
- ✓ Compensation for unpaid costs on other modes.
- ✓ Non-discriminatory mark ups but these must not be excluded segments of traffic which could cover direct cost.

The direct cost of operating the service is to be interpreted as *short run marginal social cost* according to Nash (2004). Moreover, there is allowance for second best pricing in the face of distorted prices on other modes.

2.1. Infrastructure Charging

Following Nash (2004), there is no single set of infrastructure charging principles that will be optimal in all circumstances. If the government is willing to fund a large part of infrastructure costs, and takes infrastructure development decisions on the basis of cost-benefit analysis, then "pure" short-run marginal social cost pricing may be the best solution. Where there is a monopoly operator, for instance as a result of franchise competition, two-part tariffs will be best. Where there is on-track competition, but government funding is limited, marginal cost pricing with mark-ups will be needed (Ramsey-type). If there is on track competition on track owned by a private company, then infrastructure pricing is particularly difficult unless the market is sufficiently insensitive to price that simple average cost pricing is not too distorting.

Table 1 (taken from Nash, 2004) illustrates the structure of charges for the majority of European countries. The most common system is a simple charge per train/kilometre, which may be differentiated by type of traction, weight, speed and axle-road of the train. Note the difference between a train-km and a path-km. Path kilometres are a number of km of a reserved train section. These km are not necessary driven. Train/kilometres are km effectively driven.

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

Table 1: Structure of the charges in Europe (from Nash (2004))

Country	Infrastructure levies per freight train-km in euros	Infrastructure levies per passenger train-km in euros	Type of infrastructure charging system
NO	0.5	0.0	Marginal Costs Pricing
SE	0.3	0.5	Marginal Costs Pricing
PL	7.75	2.1	Full Costs Pricing
DE	3.8	5.2	Marginal Costs Pricing
HU	4.5	2.5	Full Costs Pricing
RO	4.6	1.5	Full Costs Pricing
BG	4.2	1.6	Marginal Costs Pricing
GR	5.0	2.5	Full Costs Pricing

Table 2: Infrastructure levies in Euros per train-km based on the ECMT report of 2005. Figures are presented only for the countries along the rail corridor investigated in RE-ORIENT project.

The directive 2001/14/EC requires in Articles 7 and 8 for the charging of rail infrastructure the following:

- ✓ Charges are to be set at the cost directly incurred as a result of operating the train service
- ✓ Cost that reflect scarcity of capacity during periods of congestion are allowed
- ✓ Charges to cover environmental costs are allowed. However, if they increase the revenue of the Infrastructure Manager (IM), they may only be charged, if competing modes of transport apply these charges on a comparable level
- ✓ Mark-ups on the basis of efficient, transparent, and non-discriminatory principles can be applied to recover the total costs, if the market can bear this. For market segments, that are not able to pay these mark-ups, the charge should only cover the costs that are directly incurred by the train run
- ✓ Higher charges can be set to cover the costs of investment projects on the basis of the long-run costs, if they increase the efficiency and /or cost-effectiveness
- ✓ To prevent discrimination, the charges for equivalent uses have to be comparable and comparable services in the same market segments are subject to the same charges
- ✓ Discounts are only allowed to give savings in administrative costs to the customers or to encourage the use of a specific infrastructure section for a limited time without discrimination.

2.2. Short-Run Marginal Cost Pricing

Marginal costs are the costs which are incurred by an additional train run. The notion of incremental costs is used as well, the difference being the way the costs are measured. As external costs are substantial (Nash, 2003) they should be included in the infrastructure charge. If marginal costs are considered only in the short perspective, they will not cover the costs of upgrading and creating new infrastructure. Short Run Marginal Cost (SRMC) pricing results in a deficit because of scale economies and a high proportion of fixed costs. The deficit will be partly covered, if externalities are considered in the pricing system. However, the charging of externalities should not be a financing instrument in order to guarantee allocative efficiency. The deficit is usually covered in European countries by the government with general taxes. A theoretical solution for the deficit is Ramsey-pricing. The aim of Ramsey-pricing is to maximize social welfare under the constraint of deficit coverage. It tries to find mark-ups for different products to cover the deficit that results from SRMC-pricing. The inverse elasticity rule is applied to define these mark-ups. A rough example in the railway sector is peak-load pricing.

Fully-Distributed Cost (FDC) pricing take the SRMC as a starting point. They cover the deficit by allocating the remaining costs according to selected parameters. Usual parameters are track-km, revenues, or the SRMC themselved (Rodi, 1996).

Non-linear tariffs charge different prices per unit for different amounts of slots. The basic idea is to charge every slot with its marginal costs and to cover the resulting deficit with a fixed fee, that the operator has to pay for a certain period of time –entrance fee-.

2.3. Details on organization of railways by country along the RE-ORIENT railways corridor

2.3.1. Norway

Norway is not part of the European Union, but being part of the European Economic Area, is required to implement the same laws as the EU Member States through the bilateral agreements that it has entered into with the European Union. The liberalisation of the Norwegian rail network is well underway with the separation of the infrastructure from the incumbent operator having occurred in the late 1990s and a full licensing and regulatory regime having been set up during that time period, the majority of which being in place prior to the passing of the First Infrastructure Package of Directives. The sections below look in more detail at each of the provisions.

The Norwegian rail network has been open to freight competition since the 15th March 2003, the date by which EU countries were due to have implemented Directives 2001/12, 13 and 14, and was already compliant with the Directives when then came into existence.

Accounting separation occurred in Norway in two phases, firstly the former state monopoly was divided into an operating arm (NSB) and an infrastructure manager (Jernbaneverket) on 1 December 1996, at this point both NSB and Jernbaneverket had the same board of directors and to the same chief executive. On 1 July 1999 the reporting line to the single board and chief executive was removed and the two companies were separated fully. They both remain under the ownership of the Ministry of Transport and Communications. 1.9 The freight operations of the incumbent operator, CargoNet AS, are now partially owned (45%) by the Swedish freight company GreenCargo AB, as a result of the different ownership structure and the requirements of the EU Directives, the freight operations have dedicated accounting results within the overall accounts of NSB.

It is true that the ultimate owner of both the operating company and the infrastructure manager is the Ministry but given the length of time that the companies have been separated and the lack of complaints to date on the current structure seems to suggest that for the moment the separation reflects the needs of the market. This will need to be reviewed when a larger number of participants are involved in the industry.

Infrastructure Manager

Jernbaneverket is an administrative body under the Ministry of Transport and Communications. It is responsible for the management of the national railway network, on behalf of the Ministry of Transport and Communication. Through public funding it operates, maintains and develops the national railway network. The National Rail Administration is responsible for:

- ✓ Developing and operating a rail network that meets the requirements of
- ✓ Norwegian society and the market;
- ✓ Railway stations and terminals;
- ✓ Timetabling;
- ✓ Traffic management; and
- ✓ Studies and planning in the rail sector

Railway undertakings

NSB AS is a state-owned limited railway company (Norges Statsbaner). The NSB Group's main activities comprise passenger traffic on trains and buses and freight traffic on the railway network through CargoNet.

The other operators that run services on the Norwegian network are Malmtrafikk AS (a company looking after cross-border iron-ore flows from Sweden to Norway),Ofotbanen AS, Connex Tog AS and Flytoget AS (a subsidiary of NSB).

2.3.2. Sweden

In the years following separating infrastructure from rail operations in 1988 the liberalization process was initiated in Sweden. Regional and national authorities started to tender passenger rail services prior to the implementation of Directive 91/440 (adopted into Swedish legislation 1996 through SFS 1996:734). Free access to the freight market was introduced in 1996. Accounting separation was introduced in Sweden in 1985 when the infrastructure and railway operations were separated within the state railways. 1988 Sweden took the next step and separated *ownership and management* of the State's infrastructure completely from the state railways by establishing the independent state authority Banverket.

The deadline for the implementation into national law of the First Infrastructure Package of Directives was set at the 31 March 2003. Sweden did not meet this deadline and was later taken to the European Court by the EU-Commission (together with eight more member states) for not adopting the Directives into national law. However, as the Swedish railway sector fulfilled implicitly a number of the directives' demands (separation of infrastructure and railway operations, price setting and capacity allocation independent of single railway operators) Sweden headed rather for a review of the existing organization than for a re-organization.

On the 1st July 2004 Sweden implemented the majority of the First Infrastructure Package of Directives (without charging and network statement) into Swedish legislation by acquiring the Railway Act SFS 2004:519 and the Railway Ordinance SFS 2004:526.

Banverket is an authority under the Ministry of Industry, Employment and Communication. Banverket is in charge of allocating capacity, billing infrastructure charges, producing the annual timetable and operating, maintaining and developing the Swedish rail network. Banverket is not only responsible for the railway infrastructure but also for the development of the Swedish railway sector in total. This includes a neutral role towards all companies that run services on the network.

Infrastructure management

While the short-term socio-economic marginal costs for using the rail infrastructure are born by the railway operators through the infrastructure charges, the residual costs are born by national funding to Banverket. Government funding to Banverket amounted in 2004 to €1.2 billion[5] Municipalities and counties co-finance regional passenger railway services to the tune of approximately €282 million.

The user fees are set by the Swedish Government. The charging framework is based on a marginal cost approach that aims at covering the short-term socio-economic marginal costs. The parameters that determine the user fees are gross ton-kilometres hauled (user fee for passenger traffic, user fee for freight traffic, passenger information fee), number of shunted wagons (marshalling yard fee), train-kilometres (accident fee passenger/freight traffic) and liters of consumed diesel (diesel charge). For crossing the Øresund bridge a fixed amount per train and crossing is charged.

2.3.3. Poland

Directive 91/440 was passed into Polish law with the 2000 Railway Act on restructuring, commercialization and privatization of the Polish State Railways, Polskie Koleje Panstwowe (PKP), only after it became clear that Poland would join the EU. Though Polish legal regulations before April 2003

were even more restrictive than the European ones, in practice, PKP kept their monopolist position in the country. With the Act on Railway Transport of 28 March 2003, Poland implemented the First Infrastructure Package. It harmonized to a very large extent Polish legislation with Community law in the area of licensing and railway capacity allocation procedures. In principle, this Act responds to the Directives 2001/12/EC, 2001/13/EC and 2001/14/EC.

On 1 January 2001, the state railway company PKP was transferred into a capital holding company with 107 companies (35 of which are 100%-owned). The dominant entity is PKP S.A., which controls all PKP passenger and cargo operations. PKP S.A. shares are fully owned by the Ministry of Finance. The infrastructure of the PKP Group is managed by PKP PLK S.A. which forms an integral part of the PKP Group but has separate accounting.

In order to formally separate PKP infrastructure management and PKP operations and thus increase the independence of the infrastructure manager, the Polish Government (represented by the Ministry of Infrastructure) plans to take over completely all PKP shares in PKP PLK. It will also get financial support from the state budget (about €100 million in 2006). Similar to the German model, from January 2006 the Government plans to establish a Fund responsible for the transfer of PKP assets to the different companies and administration of residual assets and liabilities.

The Polish railway network is administrated by 13 infrastructure managers, of which the two major ones are PKP PLK S.A. and PKP LHS Ltd. The remainder are mainly small networks of manufacturers or dedicated lines e.g. between coalmines and power stations.

Infrastructure management

Generally, infrastructure tariffs as laid out in the network statement are *cost-based*. However according to the 2003 annual report of PKP PLK S.A. the financial year 2003 ended with a loss of about €59 million, a little less than expected.

2.3.4. Germany

Since the middle of the 1950s, the German public railway organisation Deutsche Bundesbahn has lost a substantial part of its market share to other transport modes: from 1960 to 1990 its share of the passenger market decreased from 36 % to 6.1% and in freight from 56 % to 20.5%.1 Against this background, the German government initiated a railway reform programme (liberalisation and privatisation), first by establishing the Regierungskommission Bahn (governmental commission on the railways or RKB) in February 1989. The RKB issued its final report in December 1991. The reform itself came into force on 1 January 1994. Two new laws were set up or amended as a basis for the radical change in the railway system and the German constitution had to be adjusted.

A major part of the railway reform was the shift of responsibility for the provision of Regional Passenger Transport Services by Rail (RPTR) from the federal government towards the 16 states (regionalisation). The new system delegates a considerable variety of options towards the states: most importantly, funds are not earmarked for rail, although by law must be used for public transport (RPTR and bus service). In particular, the states are free to contract with anyone, e.g. DB AG or its newly established competitors, although there is still debate as to whether public procurement law is binding or voluntary. The states can choose between different contractual forms and service specifications (e.g. contracting for networks or lines; tendering precisely described services vs. incentive contracts; contract terms).

To prepare the third step of the rail reform, the task force "Zukunft Schiene" (Future of Rail) was founded in 2001, with a mandate to find the "best" and most workable solution for the structure of the German railway sector. This can be seen as both a reaction to the First Railway Package and a means of preparing the continuation of the German railway reform of 1994. Unexpectedly, and unlike the publicly announced goal of the German Transport Minister, the Task Force proposed that DB Netz AG (Infrastructure manager) should remain part of the centrally led holding. This can be attributed mainly to DB AG`s CEO Mehdorn, who emphasised the synergies inherent in an integrated company. To date, the

third step in the reform, to privatise (parts of) DB AG has been discussed, but does not seem to be near realisation.

Separation of accounting started formally in January 1994 with the establishment of an Infrastructure Manager (DB Netz AG) by law. However, the accounting instruments were not sophisticated enough at this time to allow a full separation of accounting.

According to the new AEG (Algemeines Eisenbahn gesetz – General railway law), accounting has to be separated between the transport units and the infrastructure units of railway companies. The transfer of public subsidies between those units is not allowed.

Separate Annual Reports for different business units of DB AG are available from 2001 onwards. In contrast with the spirit of the second step of railway reform and the recommendations of the 2001 task force, the Executive Board of DB AG has reduced the level of transparency by publishing only the reports of the original subsidiary companies. Spin-offs and new acquisitions, such as Stinnes (a transport and logistics company), are outside the public microscope. Some functions (e.g. financing) are stillnot separated (see "Bahn finanziert mit zwei Anleihen Stinnes-Kauf", Die Welt, July 11th 2002). Many experts are still criticizing the structural intransparency of the use of public money within DB AG.

New entrants report that the transport units of DB AG do not receive explicit bills for infrastructure charges from DB Netz (infrastructure manager). There are also serious doubts whether subsidiary companies pay charges in full (Buchanan, 2005).

Infrastructure Managers

Deutsche Bahn Netz AG (DB Netz) is responsible for infrastructure development, investment and financing, producing the annual timetable, operating and maintaining the rail network, allocating and charging capacity. DB Netz has been established in 1994 as a subsidiary company under the roof of DB AG.

Within the management board of DB AG holding, DB Netz is represented together with DB Station&Service (DB Stations) by Stefan Garber, Member of the Management Board for "Infrastructure and Services", since March 2005.

In Germany about 110 other Infrastructure Managing Companies operate a network of approximately 5,000 km. In general they have the same functions and obligations as DB Netz AG, and most of them are public companies, owned by states, municipalities, counties, or by public ports. Another small group are regional spin-offs of DB Netz.

Railway Undertakings

Within DB AG, railway services are mainly operated by DB Fernverkehr AG (long distance passenger transport), DB Regio AG and its subsidiaries (regional passenger transport) and Railion (freight transport). DB also operates urban transport (by DB Stadtverkehr GmbH) and road, sea and air transport/logistics (by Stinnes AG and Schenker AG).

DB`s business unit Fernverkehr had 22,700 employees in 2004 and an annual turnover of €2.9 billion in 2004, while operating at a loss of €260 million. DB Fernverkehr moves 320,000 passengers per day and handled a total of 32,330 billion passenger kilometres in 2004.

The business units regional and urban transport (which also contains a bus subsidiary) had an annual turnover of €8.13 billion in 2004, made a profit of €499 million and employed 42,600 staff by the end of that year. 4.28 million passengers per day used DB Regio services in 2004.

Railion Deutschland AG operated 5,021 trains per day and transported 77.62 billion tonne kilometres in 2004. The whole DB business unit transport & logistics including Schenker had a turnover of €11.57 billion and 62,117 employees. Due to merger and acquisition activities as well as expansion policies, Railion also operates in the Netherlands, Denmark and Italy.

More than 300 railway undertakings hold an operating licence. A large number consist of port railways, narrow-gauge and museum railways. Others are spin-offs from successful bids for regional passenger transport services; some are limited to regional activities on a small scale. Only a few companies are serious players in the nationwide market.

In the sector of long distance passenger transport, the competitors of DB AG do not play any significant role: The only services currently run by other TOCs are:

- ✓ InterConnex between Gera and Rostock (one train pair daily) and between
- ✓ Dresden and Stralsund (two train pairs per week);
- ✓ Vogtlandbahn (Arriva) between Plauen and Berlin, operated since June 2005;
- ✓ the Berlin Night Express between Berlin and Malmö in Sweden, run by Georg Verkehrsorganisation.

Other experimental flows have been cancelled for economic reasons or due to unsolved path conflicts.

In the regional sector the following companies play a significant role, defined as an aggressive market approach with focus on all tenders in Germany: Arriva (Regentalbahn, Prignitzer Eisenbahn PEG); Connex with various franchises; Abellio (former public company, now 75% private); and Hamburger Hochbahn (public company). After having entered the market vigorously, Rhenus-Keolis changed its strategy and does not bid nationwide any longer. What Transdev (brand: Eurailco) intends to do, remains to be seen. New entrants had a combined share of about 12% in 2004 in the regional and local markets (measured in terms of train kilometres) but only carried 5.3% of passenger kilometres.

In the freight sector. most of the relevant players (e.g. Rail4Chem, TX Logistik) are organised in the "Netzwerk Privatbahnen" (network of private railways). In 2004 the network reached a market share of 8.8%.This figure is equivalent to nearly one third (31.6%) of growth in tonne kilometres (7.6 billion tonne kilometres) from 2003 to 2004. The total market share of the competitors is about 10% according to DB figures.

2.3.5. Hungary

In preparation for accession into the EU, Hungary enacted a number of laws and regulations aimed at implementing railway liberalization. The 1993 Railways Act started the process; this was recently amended to take account of the provisions in Directive 2001/12/EC. A Ministerial Decree was published in 2002 to enact Directive 2001/13/EC while the provisions that focused on Directive 2001/14/EC were enacted in 2003 with Ministerial Decrees 67/2003 and 66/2003.

The overall structure of the industry in Hungary is shown in Figure 1.1. Accounting separation has occurred, although MAV has remained an integrated operator it has split itself into 5 business units (including separate infrastructure and railway undertaking units).

The Hungarian railway network infrastructure is managed by two separate companies: MAV and Gysev. The two companies' railway undertakings use each others railway network, the differentiating factor being that the Gysev network is used mainly for international freight traffic while the MAV network is used mainly for domestic, local regional and intercity passenger trains as well as national freight trains.

MAV is the incumbent railway undertaking operating both freight and passenger services on the national network. While MAV still operates and maintains the railway infrastructure the network remains directly controlled by the State. The Infrastructure business unit of MAV is responsible for managing the infrastructure. Gysev is a concession holder, with the State purchasing its services under contract. Its main railway undertaking operations are in the West of Hungary and in the area of the Hungarian-Austrian border where it manages 2% of the total Hungarian railway network. Its contract is due to expire in 2007, upon completion the infrastructure is returned to the State.

The Hungarian Railways are funded through a combination of access charges paid by the operators and State contracts. The access charges cover approximately 80% of the total costs incurred by the infrastructure. The remaining 20% is financed through subsidy payments made by the State to the infrastructure manager. This contract is valid for 3 years and the level of subsidy payment (as well as the contract as a whole) will be re-negotiated at that time.

The charges for access to the rail infrastructure in Hungary are determined by VPE, the capacity allocation body, following the guidance in the Joint Decree 66/2003. These charges are divided into a base charge and charges reflecting the other services that the infrastructure manager offers. The base charge, covering the minimum level of service, is a two-tier tariff split between a distance based charge (variable) and a reservation fee (fixed). The table below sets out the categories of the basic charge.

The charging structure that is in place in Hungary is compliant with the framework set out in Directive 2001/14/EC in that it seeks to recover the marginal costs of running trains on the network by using a proxy for these marginal costs, the variable cost of running trains on the network based on the distance travelled by each train.

2.3.6. Greece

Greece is not advanced in terms of rail liberalization, as the existing environment provides significant barriers to entry and to date a structure based on a single entity providing services has been retained. This is partly because Greece obtained certain derogations from elements of the First Railway Package. These derogations are for a period of five years from 15 March 2003 and apply to Greece on the basis that it does not have any direct rail link to any other Member State. Nevertheless, Greece completed the transposition of Directives 2001/12/EC, 2001/13/EC and 2001/14/EC into national Legislation on 7 March 2005.

OSE has in essence remained a single entity that provides all the services to the rail industry, although distinct internal divisions have been created and accounting separation introduced, in line with 91/440.

There are provisions in P.D. 41/2005 for the infrastructure-charging scheme to include penalties and performance incentives, in line with Article 11 of Directive 2001/14 although the general principles presented in the Directive have not been defined in any stricter terms.

Until recently, and although Directive 91/440 has long been transposed into national legislation, the Greek state has retained the structure of a single entity providing all services to the rail industry. The government continues to have a light degree of direct control of OSE. The rail market in Greece is therefore currently dominated by OSE, the current state owned combined infrastructure manager and monopoly passenger and freight railway undertaking. The existing rail sector in Greece is subsidized, both in terms of development and maintenance of the network and in support of operations.

3. Description of the general structure of the model

We consider N countries denoted by i= 1,2,…,N. The countries' railways infrastructure forms an international transport corridor and they share transport demands over this corridor. In a country an infrastructure manager sets access charges, while the downstream firms use the network to provide the transport services to the final consumer. The downstream firms produce national passenger and international freight services. Information is complete for both the infrastructure manager and the downstream firms in a given country and across the countries.

The transportation demand over the international corridor is associated with the consumer surpluses of passenger and freight transportation, respectively. The overall corridor consumer surpluses are distributed unevenly between the countries; each of them internalizes only a part of this surplus. The part of the surplus internalized by each country is proportional to the amount of internal passenger traffic and international freight traffic originating and ending in the country.

It is assumed that the railways infrastructure managers in each country are public agents so that they do not make profits. An individual country's welfare consists of the surplus, profits of the downstream firms/railways companies and the governmental subsidies for infrastructure provision. The rule for setting an infrastructure access charges explicitly depends upon the infrastructure charging regime in the particular country. Countries use either marginal costs or full costs infrastructure pricing principle.

A number of the downstream firms produce national passenger and international freight transportation services using the railways infrastructure in the countries along the corridor. It is assumed that passenger transport services are bought only by the domestic consumers, whereas the freight services are bought only by the international consumers. Each railways operator is able to provide international freight transportation services on the whole infrastructure of the international railways corridor. That is there is made an assumption of the seamless railways.

It is also assumed that the national infrastructure managers cannot differentiate between the downstream firms and treat all of them in the same way. The downstream firms from different countries along the corridor compete over the freight demand served by the international railways corridor. The passenger demand is assumed to be served only by the downstream firms in the country where it originates from.

We make an assumption of the oligopolistic structure of the freight railways market. That is each country along the corridor is associated with a single railways operator. In case of oligopoly, the prices of final transportation services depend upon the marginal costs of production and upon the price elasticity of the demand and number of the national railways operators.

Described analytical framework is designed for the evaluation of various effects, associated with the different regimes of the railways infrastructure charging. A set of the outputs is associated with each type of such funding regime. Main outputs include such important elements as: country-specific welfare, weighted overall international welfare, national consumer surpluses, changes in the demand for international and domestic railways services, changes in prices of railways services, profits of the railways services providers, , changes in the railways infrastructure subsidies etc.

4. Description of the data used for calibration of the model

The following data sets and information have been used for the construction of the described analytical framework:

- ✓ Balance sheets and income statements of the railways companies in all of the countries along the railways corridor; those should include both infrastructure related and operations related costs (this data is available from the NERA report of 2004 and recent ECORYS 2006 report) see Table 3 below.
- ✓ National and international freight and passenger demands for railways services along the corridor (may be available from the precious RE-ORIENT work packages and/or national transportation statistics)
- ✓ Information of the infrastructure funding regime in each country (final reports of RAILIMPLEMENT and Buchanan and partners) see previous chapter

Income statements for 2001 in millions Euros POC=Public Operating Contributions PBC=Public Budget Contributions	BG	DE	GR	HU	NO	PL	RO	SE
Passenger-km (in mlns)	2990,0	74459,0	1747,0	7261,0	2536,0	18208,0	10965,0	6352,0
Tone-km (in mlns)	4905,0	80348,0	379,0	7307,0	2451,0	47651,0	15899,0	19829,0
Traffic units (in mlns)	**7895,0**	**154807,0**	**2126,0**	**14568,0**	**4987,0**	**65859,0**	**26864,0**	**26181,0**
Passenger-train-km (1000)	25034,0	721700,0	14727,0	79831,0	24114,0	161324,0	67826,0	63500,0
Freight-train-km (1000)	12159,0	226900,0	159,0	16074,0	8368,0	80108,0	29191,0	35900,0
Total train-km (1000)	**37193,0**	**948600,0**	**16306,0**	**95905,0**	**32482,0**	**241432,0**	**97017,0**	**99400,0**
Railway staff total	37260,0	214371,0	9601,0	54287,0	9128,0	158763,0	101418,0	16120,0
Length of lines (km)	4320,0	35938,0	2377,0	7516,0	4178,0	20134,0	11364,0	9946,0
Passenger traffic receipts	35,0	6550,0	51,7	140,0	256,0	513,0	125,0	584,6
Freight traffic receipts	112,0	3896,0	24,8	239,0	139,3	1389,0	389,0	492,7
Other traffic receipts	0,0	762,0	8,2	48,0	79,9	183,0	213,0	0,0
Total traffic receipts	**147,0**	**11208,0**	**84,7**	**481,0**	**475,2**	**2085,0**	**727,0**	**1077,3**
Receipts from infrastructure charges	0,0	0,0	0,0	0,0	0,0	0,0	0,0	9,4
Total other operation income	49,0	4219,0	2,0	98,0	18,5	349,0	8,0	698,4
Total operation income	**196,0**	**15427,0**	**86,7**	**579,0**	**493,7**	**2434,0**	**735,0**	**1785,0**
Total staff costs	108,0	8003,0	280,1	402,0	461,9	1326,0	326,0	800,5
Material purchases	93,0	10712,0	61,9	371,0	513,4	880,0	808,0	1112,8
Infrastructure levies	0,0	0,0	0,0	0,0	0,0	1,0	0,0	0,0
Depreciation	39,0	2162,0	57,5	162,0	54,5	1198,0	25,0	380,2
Taxes	0,0	-3,0	1,3	10,0	1,7	80,0	16,0	0,0
Total operating expenditures	**240,0**	**20874,0**	**400,8**	**945,0**	**1031,5**	**3485,0**	**1175,0**	**2293,5**
Net financial charges	-13,0	-311,0	-95,1	-46,0	6,5	-105,0	-13,0	-132,1
Other terms	-19,0	0,0	35,1	11,0	-55,2	15,0	21,0	-193,7
Total financial results	**-32,0**	**-311,0**	**-60,0**	**-35,0**	**-48,6**	**-90,0**	**8,0**	**-325,9**
Result without POC	**-76,0**	**-5758,0**	**-374,1**	**-401,0**	**-586,4**	**-1141,0**	**-432,0**	**-834,3**
PBC for infrastructure	6,0	838,0	0,0	0,0	582,7	0,0	204,0	463,0
PBC for operations	32,0	4514,0	0,0	284,0	151,7	211,0	184,0	15,0
Total PBC	**38,0**	**5352,0**	**0,0**	**284,0**	**734,4**	**211,0**	**388,0**	**478,0**
Net result	**-38,0**	**-406,0**	**-374,1**	**-117,0**	**148,0**	**-930,0**	**-44,0**	**-356,3**

Table 3: Income statements of the railways sector from the NERA report of 2004 for the countries along the RE-ORIENT corridor

To build the model according to the previous analytical framework, data on the flows between the countries are needed. The UMD data for the baseline contains a table with the weekly flows, disaggregated by NUTS2 region and NSTR commodity type. These weekly flows were then multiplied by 52 to get yearly flows and summed over the commodity types. To transform these yearly tons into tons per km (tonne-km) they were multiplied by the distance between them.

These distances were taken from the prices table in the ETIS data. In this table the prices are given for transport between different origin-destination pairs. By dividing this price by the prices per km, which are disaggregated by type of NSTR commodity but do not differ between countries, the distance for a given mode of transport between an origin-destination pair can be calculated. The distances calculated in this way for different types of goods are identical.

Summation over the different NUTS2 regions allows then to calculate the tonne-kms going from one country to another country. It should be noted that the ETIS data was collected for the EU25, thus before the accession of Romania and Bulgaria. As a consequence, the flows from and to these two countries (and especially between them) are very uncertain.

The framework for the infrastructure charging developed above assumes that there is one unbroken railway line/ road going through all the countries in the corridor. This is a simplification of reality that allows focusing on the objective of the model without needlessly complicating the model by taking route choice into account. The assumption also implies that the countries lie in a line such that each country is only connected to two neighbours (except at the ends who only have one neighbour). Looking at the map of North and Eastern Europe, it is clear that this is not true for the countries in the RE-ORIENT corridor. Therefore some countries were taken together; specifically Germany, the Czech Republic and Slovakia were taken together, as were Austria and Hungary and as were Serbia and Montenegro and Romania.

After these steps the model requires that the tkm's are divided over the different countries they pass through en route from their origin country to their destination country. A natural way to do this is to divide the tkm's between an origin-destination pair proportionally over the countries by using the proportions of the length of the link passing through each of the countries. As the assumption is that there is only one link (one for railway and one for truck) per country, a transport going through a country has to pass over the entire link length. This is a simplification of reality.

The data received from UMD also contains a detailed map of the roads and railways that are considered part of the RE-ORIENT corridor. This map is in the form of nodes with links between them, where each link has a given length. By summing up all the lengths between nodes for a given mode inside a country (cross-country links were split in half) the total RE-ORIENT network length was calculated. To reduce these lengths to more realistic figures for a single line per country, they were divided by a factor that seemed appropriate judging from the maps on the RE-ORIENT website. By using these lengths the tkm's were then assigned proportionally to the different countries.

To calculate the vehicle kilometres the tonne-kms were divided by load factors taken from the TREMOVE model. These load factors can be found in the Table 4 below.

Country	Truck	Rail	Notes
NO	6.88	175.61	
SE	6.88	482.79	
PL	7.7	659.46	
DE	7.94	338.56	
HU	7.7	419.53	
RO	7.7	419.53	Copied from Hungary
BG	7.7	419.53	Copied from Hungary
GR	7.07	277.88	

Table 4: Load factors for freight transport taken from the TREMOVE model, in tonnes per km.

	NO	SE	PL	DE	HU	RO	BG	GR
NO	12,393	5,070	15	1,460				9
SE	1,160	14,807	106	1,170	7		4	258
PL	5	98	15,771	1,600	79	10		22
DE	187	897	3,852	78,591	2,920	532	213	887
HU	5	20	67	1,458	13,074	74	24	4,160
RO			2	250	495	430		52
BG				68	121	159	1,752	82
GR	1	13	108	395	1,548	3,299	2,221	8,966

Table 5: Origin-destination (O-D) matrix of the railways transport flows for the countries along the RE-ORIENT corridor in 1000 vehicle-km

5. Detailed mathematical formulation of the model

Indexes $i,j,k,l \in \{NO, SE, PL, DE, HU, RO, BG, GR\}$ denote the European countries along the RE-ORIENT railways corridor. These countries are split into two groups according to their railways infrastructure pricing systems.

The first group of the countries follows the marginal costs infrastructure charging principle and consists of the subset $MCP = \{NO, SE, DE, BG\}$. The second group of the countries follows the full costs infrastructure charging principle and consists of the subset $FCP = \{PL, HU, RO, GR\}$.

The following paragraphs give the full mathematical formulation of the industrial organization model used for the analysis in the RE-ORIENT project.

Technical parameters of the model	
$shareL_{k,j,i}$	share of the km in country i in the total route from k to j
σP_i	price elasticity of the domestic passenger services
σFT	elasticity of substitution between train service providers
σFRT	elasticity of substitution between road and rail modes
$shareFTR_{k,j}$	initial share of transportation by railways mode
$shareFT_{k,j,i}$	initial share of the train transportation from country k to country j served by railway company in country i

Table 6: Technical parameters of the model

Model variables	
Railway operators	
FC_i	fixed production costs of the railway company
FCT_i	taxes in addition to the fixed costs
FCS_i	subsidies in addition to the fixed costs
MC_i	marginal production costs of the railway company per train-km
MCT_i	taxes in addition to the marginal costs per train-km
MCS_i	taxes in addition to the marginal costs per train-km
SP_i	subsidies for passenger travel per train-km
SF_i	subsidies for freight transportation per train-km
REV_i	revenues of the railway operator
$COSTS_i$	production and other costs of railway operator
$PROFIT_i$	profits of the railways operator
Infrastructure providers	
δ_i	infrastructure levies per train-km
FCI_i	fixed costs of infrastructure provider
$FCIS_i$	subsidies in addition to fixed costs
MCI_i	marginal costs of infrastructure provider
$MCIS_i$	subsidies in addition to marginal costs
$REVI_i$	revenues of infrastructure provider
$COSTSI_i$	production and other costs of infrastructure provider
$PROFITI_i$	profits of the infrastructure provider
Transport demands	
DP_i	demand for domestic passenger travel in train-km
$DF_{k,j,i}$	demand for international travel with transport operator of country i from country k to country j
$DFR_{i,j}$	demand for the transportation by road from country i to country j
$DFT_{k,j}$	total demand for freight transport from k to j
Prices	
$PFROAD_{i,j}$	price of the transportation by road
$PFTRAIN_{i,j}$	price of the transportation by rail
PP_i	price of passenger travel per train-km
PF_i	price of freight transportation per train-km
PPS_i	after subsidy price of passenger travel per train-km
PFS_i	after subsidy price of freight transportation per train-km
Countries welfare functions	
W_i	overall welfare of a country
WEU	total welfare of all the countries along the transport corridor

Derivatives of the freight demand function	
$DERF_{k,j,i}$	derivative of the freight demand function with respect to price

Table 7: Model variables

5.1. Model equations related to the railway operators

Revenues of the railways operator in each country is the sum of its revenues from domestic passenger transport services and from international freight transport services:

$$REV_i = DP_i \cdot PP_i + \sum_k \sum_j \left(DF_{k,j,i} \cdot PF_i \right) \tag{1}$$

The total production costs of the national railways operator in each country is equal to total fixed costs plus the total fixed taxes minus subsidies plus the marginal production costs multiplied by the overall production volume of the company in train/km plus the infrastructure charges paid to both domestic and foreign infrastructure providers:

$$\begin{aligned} COSTS_i &= FC_i + FCT_i - FCS_i + \left(DP_i + \sum_k \sum_j \left(DF_{k,j,i} \right) \right) \cdot \left(MC_i + MCT_i - MCS_i \right) \\ &+ DP_i \cdot \delta_i + \sum_{k \le j} \sum_{k \le l \le j} \left(DF_{k,j,i} \cdot shareL_{k,j,l} \cdot \delta_l \right) \\ &+ \sum_{j \le k} \sum_{j \le l \le k} \left(DF_{k,j,i} \cdot shareL_{k,j,l} \cdot \delta_l \right) \end{aligned} \tag{2}$$

Total profits of the national railways company are equal to its revenues minus total production costs:

$$PROFIT_i = REV_i - COSTS_i \tag{3}$$

5.2. Model equations related to infrastructure providers

The infrastructure charges of the countries are determined according to either marginal costs rule for the countries in the MCO subset or according to the full costs rule for the countries in the FCP subset:

$$\begin{aligned} \delta_i &= \left(MCI_i - MCIS_i \right), i \in MCP \\ \delta_i &= \left(\left(MCI_i - MCIS_i \right) + \left(FCI_i + FCIS_i \right) \right) / \left(DP_i \right. \\ &+ \sum_{k \le j} \sum_{k \le l \le j} \left(DF_{k,j,l} \cdot shareL_{k,j,i} \right) \\ &+ \left. \sum_{j \le k} \sum_{j \le l \le k} \left(DF_{k,j,l} \cdot shareL_{k,j,i} \right) \right), i \in FCP \end{aligned} \tag{4}$$

Revenues of the infrastructure provider is calculated as the level of the infrastructure charges multiplies by the total demand for infrastructure services from both domestic and foreign railways companies:

$$\begin{aligned} REVI_i &= \delta_i \cdot \left(DP_i + \sum_{k \le j} \sum_{k \le l \le j} \left(DF_{k,j,l} \cdot shareL_{k,j,i} \right) \right. \\ &+ \left. \sum_{j \le k} \sum_{j \le l \le k} \left(DF_{k,j,l} \cdot shareL_{k,j,i} \right) \right) \end{aligned} \tag{5}$$

Total production costs of the infrastructure provider is calculated as the sum of the total fixed costs minus the subsidies on the fixed costs plus the marginal costs minus marginal subsidies multiplied by the total demand for the infrastructure:

$$COSTSI_i = FCI_i - FCIS_i + \left(MCI_i - MCIS_i\right)/\left(DP_i + \sum_{k\le j}\sum_{k\le l\le j}\left(DF_{k,j,l}\cdot shareL_{k,j,i}\right) + \sum_{j\le k}\sum_{j\le l\le j}\left(DF_{k,j,l}\cdot shareL_{k,j,i}\right)\right) \quad (6)$$

The profits of the infrastructure provider are calculated at its revenues minus production costs:

$$PROFITI_i = REVI_i - COSTSI_i \quad (7)$$

The level of the subsidies on the fixed production costs of the infrastructure provider is set such that the total profits of the infrastructure manager are equal to zero:

$$PROFITI_i = 0 \quad (8)$$

5.3. Model equations describing transport demands

In the following equations the subscript "0" refers to the initial price of the passenger railways services. The demand for the passenger railways services is a function of the initial level of demand, initial price level and the price elasticity of passenger demand:

$$DP_i = DP_i^0 \cdot \left(\frac{PPS_i^0}{PPS_i}\right)^{\sigma P_i} \quad (9)$$

Demand for the international railways freight services from country k to country j, provided by the railways company in country i, is derived according to the Constant Elasticity of Substitution (CES) function and depend upon the total expenditure on the transportation by railways, the relative prices of services produced in different countries and the elasticity of substitution:

$$DF_{k,j,i} = PFTRAIN_{k,j}\cdot DFT_{k,j}\cdot\left(\frac{shareFT_{k,j,i}}{PFS_i}\right)^{\sigma FT}\cdot\frac{1}{\sum_l\left(\left(shareFT_{k,j,l}\right)^{\sigma FT}\cdot\left(PFS_l\right)^{(1-\sigma FT)}\right)} \quad (10)$$

In the following equations the subscript "0" refers to the initial expenditure on transportation from country k to country j, which is assumed to be exogenously fixed outside the model.

Demand for the international railways freight services from country k to country j is derived according to the Constant Elasticity of Substitution (CES) function and depend upon the total expenditure on the transportation from country k to country j by road and railways, the relative prices of road and rail and the elasticity of substitution between them:

$$DFR_{k,j} = TEXP^0{}_{k,j}\cdot\left(\frac{1-shareFTR_{k,j}}{PFROAD_{k,j}}\right)^{\sigma FRT}\cdot\frac{1}{\left(shareFTR_{k,j}\right)^{\sigma FRT}\left(PFTRAIN_{k,j}\right)^{(1-\sigma FRT)}+\left(1-shareFTR_{k,j}\right)^{\sigma FRT}\left(PFROAD_{k,j}\right)^{(1-\sigma FRT)}} \quad (11)$$

Demand for the road freight services from country k to country j is derived according to the Constant Elasticity of Substitution (CES) function and depend upon the total expenditure on the transportation from country k to country j by road and railways, the relative prices of road and rail and the elasticity of substitution between them:

$$DFT_{k,j} = TEXP^{0}{}_{k,j} \cdot \left(\frac{shareFTR_{k,j}}{PFTRAIN_{k,j}} \right)^{\sigma FRT} \cdot \frac{1}{\left(shareFTR_{k,j}\right)^{\sigma FRT} \left(PFTRAIN_{k,j}\right)^{(1-\sigma FRT)} + \left(1 - shareFTR_{k,j}\right)^{\sigma FRT} \left(PFROAD_{k,j}\right)^{(1-\sigma FRT)}} \tag{12}$$

5.4. Model equations describing prices

The price of transportation by rail from country k to country j

$$PFTRAIN_{k,j} \cdot DFT_{k,j} = \sum_i \left(DF_{k,j,i} \cdot PFS_i \right) \tag{13}$$

The price for the domestic passenger railways services is set according to the monopoly pricing rule and depends upon the derivative of the passenger demand with respect to price of the railways services:

$$\left(\frac{\sigma P_i}{DP_i^0} \cdot \left(\frac{PP_i^0}{PP_i} \right)^{(\sigma P_i - 1)} \cdot \frac{PP_i^0}{\left(PP_i\right)^2} \right) \cdot PP_i + DP_i = MC_i + MCT_i - MCS_i + \delta_i \tag{14}$$

The price for the domestic passenger railways services is set according to the monopoly pricing rule and depends upon the derivative of the passenger demand with respect to price of the railways services:

$$\begin{aligned} &\sum_k \sum_j \left(DERF_{k,j,i} \cdot PFS_i + DF_{k,j,i} \right) = MC_i + MCT_i - MCS_i \\ &+ \sum_{k \le j} \sum_{k \le l \le j} \left(\delta_l \cdot shareL_{k,j,l} \cdot DERF_{k,j,l} \right) \\ &+ \sum_{j \le k} \sum_{j \le l \le k} \left(\delta_l \cdot shareL_{k,j,l} \cdot DERF_{k,j,l} \right) \end{aligned} \tag{15}$$

Consumer price of the passenger railways services is equal to the after-subsidy producer price:

$$PPS_i = PP_i - SP_i \tag{16}$$

Consumer price of the freight railways services is equal to the after-subsidy producer price:

$$PFS_i = PF_i - SF_i \tag{17}$$

5.5. Model equations describing welfare functions

The welfare of each individual country consists of the profit of its railways company, domestic consumer surplus of the freight transports consumers minus the costs of the consumers of the passenger railways services minus the governmental subsidies to the infrastructure provider:

$$W_i = PROFIT_i + \sum_k \left(TEXPZ_{k,i} \cdot \left(\left(shareFTR_{k,i} \right)^{\sigma FRT} \cdot \left(PFTRAIN_{k,i} \right)^{(1-\sigma FRT)} \right.\right.$$
$$\left.\left. + \left(1 - shareFTR_{k,i}\right)^{\sigma FRT} \left(PFROAD_{k,i} \right)^{(1-\sigma FRT)} \right)^{\frac{1}{\sigma FRT}-1} \right) \qquad (18)$$
$$+ \sum_k \left(TEXPZ_{i,k} \cdot \left(\left(shareFTR_{i,k} \right)^{\sigma FRT} \cdot \left(PFTRAIN_{i,k} \right)^{(1-\sigma FRT)} \right.\right.$$
$$\left.\left. + \left(1 - shareFTR_{i,k}\right)^{\sigma FRT} \left(PFROAD_{i,k} \right)^{(1-\sigma FRT)} \right)^{\frac{1}{\sigma FRT}-1} \right) - DP_i \cdot PPS_i - FCIS_i$$

The total welfare of the countries along the RE-ORIENT railways corridor is equal to the sum if the individual welfares of the countries:

$$WEU = \sum_i \left(W_i \right) \qquad (19)$$

5.6. Equation describing the derivatives of the freight demand function

The formula for the derivative of the international demand for freight transportation by rail is based on the CES functional form of the demand function:

$$DERF_{k,j,i} = -DF_{k,j,i} \cdot \left(\frac{\sigma FT}{PFS_i} \right) + \left(1 - \sigma FT\right) \cdot DF_{k,j,i} \cdot \frac{1}{PFTRAIN_{k,j} \cdot DFT_{k,j}} \qquad (20)$$

6. Set-up of the model scenarios

Under the present situation half of the countries in the RE-ORIENT corridor use the marginal costs pricing principle to set their infrastructure charges and half of them use the full costs pricing principle to set the charges. The long-term goal of the European railways policy is to unify the infrastructure charging rules across the European countries.

The model described in full details in the previous paragraph is used in order to assess the welfare effects of the unification of the infrastructure charging rules along the RE-ORIENT railways corridor according to the following two scenarios:

- ✓ all countries of the corridor implement the marginal costs pricing of infrastructure
- ✓ all countries of the corridor implement the full costs pricing of the infrastructure

Each country of the corridor is associated with the specific welfare function presented in detail by the equation (18). The sum or the weighted sum of the country-specific welfare provides a measure of the overall welfare along the RE-ORIENT railways corridor. The model presented in the previous paragraph is used to identify the levels of the country-specific infrastructure charges which maximize the overall welfare of the corridor. The welfare functions used for this purpose include:

- ✓ the sum of the country-specific welfare functions
- ✓ the weighted sum of the country-specific welfare function, where the GDP per capita of the countries in market prices are used as weights

The use of the weighted welfare function for the corridor allows one to correct for the income inequalities between the countries. Table 8 below represents the GDP per capita in the year 2005 for the countries

along the corridor, $GDPC_i$, and the values of the constructed welfare weights, θ_i. The weights have been calculated according to the following formula:

$$\theta_i = \frac{(GDPC_i)^{-1}}{\sum_j (GDPC_j)^{-1}}$$

7. Results of the model simulations

7.1. Base case situation

First, let us calculate the welfare of the countries and the total welfare of the corridor in the base case situation, when infrastructure charging rules are different between the countries. The total welfare of the corridor is calculated as a sum of the country-specific welfare measures. Afterwards the same welfare measures are calculated for the case when all countries implement the marginal costs pricing principle and for the case when all countries implement the total costs pricing principle. Results of the calculation are represented at Table 8 below.

Country	Welfare measure in the base-case situation in Euros	Relative change in the welfare measure in case when all countries implement marginal costs principle (in %)	Relative change in the welfare measure in case when all countries implement total costs principle (in %)
NO	32,596,614	56.93	0.07
SE	105,642,799	48.20	0.12
PL	39,944,176	85.06	0.10
DE	562,818,826	1.87	-0.02
HU	117,844,556	26.90	0.03
RO	923,419	183.14	0.21
BG	588,172	420.55	0.58
GR	123,114,016	30.73	0.61
Corridor as a whole	983,472,578	35.49	0.10

Table 8: Country-specific and overall corridor welfare measures in Euros for the base case situation and for the two policy simulations: marginal costs pricing and total costs pricing for all the countries

Unification of the infrastructure charging regime along the railways corridor results in positive overall welfare effects both in the case when all the countries implement the marginal costs infrastructure charging system and when all the countries implement the full costs infrastructure charging system. The welfare effects are much larger in case of the implementation of the marginal costs principle. Increase in welfare relative to the base case amounts to 35.49% in this case. There is no clear tendency for the countries, which use full costs pricing in the base case situation, to benefit more from the shift to the marginal costs pricing. This result is explained by the close link between the countries along the corridor via the international freight flows.

The implementation of the marginal costs pricing principle results in positive welfare effects in all the countries along the corridor, whereas the implementation of the full costs pricing results in negative effects for Germany and positive welfare effects for all other countries in the corridor.

7.2. Maximizing welfare

The tables below represent the results of the simulations with the model, when the corridor welfare measure is equal to the sum of country-specific welfares and to the weighted sum of country-specific welfares respectively. Under the simulations the infrastructure charges in each of the countries are set in order to maximize the overall corridor welfare measure.

Country	**Changes on the welfare measure relative to base-case in %**	**Changes in infrastructure charges relative to base-case in %**	**Changes in the revenues of railways companies in %**
NO	73.37	-0.04	1.31
SE	61.88	-32.87	0.62
PL	109.26	-92.04	3.30
DE	5.52	-88.13	-1.87
HU	35.13	-89.09	-2.23
RO	234.24	0.01	34.72
BG	527.88	-95.87	12.73
GR	39.20	-38.98	-1.21
Corridor as a whole	46.83		

Table 9: Results of model simulation using the corridor welfare measure calculated as the sum of the welfares of the individual countries

Country	Changes on the welfare measure relative to base-case in %	Changes in infrastructure charges relative to base-case in %	Changes in the revenues of railways companies in %
NO	73.37	-0.04	1.31
SE	61.87	-32.86	0.62
PL	109.27	-92.04	3.30
DE	5.52	-88.13	-1.87
HU	35.13	-89.09	-2.23
RO	234.24	-0.02	34.72
BG	527.88	-95.87	12.73
GR	39.20	-38.98	-1.21
Corridor as a whole	69.88		

Table 10: Results of model simulation using the corridor welfare measure calculated as the weighted sum of the welfares of the individual countries

Increase in the overall corridor welfare measure presented in Tables 9 and 10 above is higher then in the case of implementation of the marginal costs pricing principle in all the corridor countries. The higher level of welfare measure is explained by the fact that infrastructure charges are set at the level lower then the marginal costs, which allows one to compensate for the monopoly pricing of the railways companies. Setting the infrastructure charges at the level lower then marginal costs leads to a decrease in the prices set by the railways companies, which has a higher positive effect then the additional governmental subsidies needed to support such infrastructure pricing rule. We make the assumption here that the costs of public funds are unity under the simulations. This means, there is no extra social cost in rising money by taxation.

Model results at the Tables 9 and 10 demonstrate that the revenues of the railways companies are mostly influenced positively by the lowering of the infrastructure charges and that the changes in the infrastructure charges are the highest for the transit countries in the middle of the RE-ORIENT corridor.

The fact that setting the infrastructure charges at the level lower then the marginal costs results in positive welfare effects is explained by the main model assumption that the railways companies act as the monopolies on their share of the market. This means that the price setting rule for freight railways services is based on the monopoly pricing principle.

The aim of the recent European reforms of the railways sector is to promote competition in both national and international railways services markets. Ideally this should lead to the market situation which is close to the perfect competition. In case this goal is reached, the optimal rule of setting the infrastructure charging will be the marginal costs principle.

8. Main conclusions

There are several interrelated conclusions, which can be drawn from the model simulation results presented in the previous paragraph:

- ✓ unification of the infrastructure charging rules along the corridor results in positive welfare effect both in case of the marginal costs pricing and in case of the full costs pricing
- ✓ welfare effects of the unification of the infrastructure charging rules are much higher in the case when the marginal costs pricing principle is implemented

- ✓ given that there exists an imperfect competition on both domestic and international markets for railways services, the optimal level of the infrastructure charges is lower then the marginal costs of infrastructure provision. A condition is of course a low opportunity cost for the use of public funds.
- ✓ the marginal costs pricing rule of infrastructure charging is thus optimal only in case of a perfect competition on the European railways market

9. References

Buchanan and partners 2005: A study on the compliance of rail border traffic agreements with EU rail and competition legislation, prepared for the European Commission

ECMT (2005), Charges for the Use of Infrastructure in ECMT Railways. Report and recommendations, Paris.

NERA 2004: "Study of the financing of and public budget contributions to railways", a final report for European Commission, DG TREN, London

Steer Davies Gleave 2005: RAILIMPLEMENT – implementation of EU directives 2001/12/EC, 2001/13/EC and 2001/14/EC, Final report