EU RAILWAY INFRASTRUCTURE TARIFF SYSTEMS: ANALYZING THE ECONOMIC INTERACTION BETWEEN INFRASTRUCTURE MANAGERS AND RAILWAY UNDERTAKINGS

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ABSTRACT

A key goal of the European Community Directive 2001/14/EC and its subsequent updates is to promote competition within the railway sector. By levying tariffs on Railway Undertakings (RUs), Railway Infrastructure Managers (IMs) are able to recover a part or all costs in operating their infrastructure. This paper examines key European High-Speed Lines from two points of view: that of the RU and that of the IM. The goal is to provide a financial estimate of RU revenues from ticket sales and of the impact of IM fees on RU revenues. From the point of view of the IM, revenues are compared to railway line construction costs in order to obtain a value for initial investment cost recovery figures for each line. Results show that IM fees make up a significant portion of RU revenues, and that IMs are able to recover all maintenance costs for most lines, and a large portion of initial investment costs. Furthermore, tariffs between different countries are not homogeneous, and present a deterrent to competition. A question is brought up of whether further European regulation is needed to deal with the issue of tariff structure and tariff level homogenization in order to promote equity in infrastructure investment.

Keywords: Infrastructure Pricing, Infrastructure Charges, European Railway Reform, High-Speed Rail, Railways

INTRODUCTION

The European Railway Reform, through various European directives, has mandated the separation of Infrastructure Management (IM) and Railway Undertakings/Train Operations (RU). European directive 2001/14/EC established a charging system, where IMs set up a charging mechanism to levy charges on RUs. The directive requires nondiscriminatory access to infrastructure and leaves some leeway as to the implementation of the directive in local laws in each country.

One of the main goals of the Railway Reform is to establish an environment that would permit competition in the market or for the market, and improve efficiency of both RUs and IMs. This would, in turn, allow the industry to increase its market share. By levying tariffs on Railway Undertakings), Railway Infrastructure Managers (IMs) should be able to recover a part or all costs of operating their infrastructure. In order to gauge how this system, which has been in existence for over a decade, is working, a financial analysis needs to be performed.

This paper first looks at the current state of the industry, summarizing the philosophy behind tariff systems, and describing the way tariff systems are implemented. Next, infrastructure tariffs for key railway lines are calculated and analyzed to provide a snapshot of the current tariff levels and infrastructure tariff evolution. In the next part, selected high-speed railway lines are examined from two points of view: that of the railway undertaking (RU) and that of the Infrastructure Manager (IM). In both cases, the goal is to provide a financial estimate of RU revenues from ticket sales and IM revenues from train operations. The latter will be compared to IM infrastructure tariff fees. Finally, IM revenues will be compared to railway line construction costs in order to obtain a value for the existing initial cost recovery figures for each line. A total of 27 countries are assessed, 25 EU countries with railway networks, as well as Switzerland and Norway.

EUROPEAN INFRASTRUCTURE TARIFF SYSTEMS: PHILOSOPHY AND IMPLEMENTATION

In order to obtain a snapshot of the qualitative aspects of European infrastructure tariff systems, a two-part analysis is performed. Each system is first categorized, based on pricing philosophy behind each system, and based on the way the system is implemented. Next, each system's structure is examined in more detail, looking at tariff concepts and variables present in each system. Finally, an analysis of the evolution of the structure between 2007 and 2012 is carried out.

Philosophy and Structure of Tariff Systems

Two general classifications exist for economic philosophies behind tariff systems that are based on the EU directive 2001/14/EC. The first is the marginal cost philosophy, where a marginal cost, or a marginal cost plus a markup is charged to the user. The second is the full cost philosophy, where the full cost of the operation and maintenance costs that the IM incurs is charged to the user, with some possible discounts.

Most IMs do not declare the philosophy behind their tariff systems and the classifications in this evaluation were based on questions and surveys of the RailCalc study, performed by one of the authors in 2008 (RailCalc, 2008), with the results shown in Table 1. A total of 16 countries adopted a marginal cost-based structure, while 11 adopted a full-cost based philosophy, with most countries adopting either a Marginal Cost Plus (10) or a Full Cost Minus (8) philosophy.

Table 1 – Tariff System Philosophy (RailCalc, 2008)

System Type	Description	Countries	Quantity
MC	Marginal Cost	Bulgaria, Greece, Ireland, Luxembourg, Netherlands (conventional lines), Norway	6
MC+	Marginal Cost Plus Additions	Austria, Czech Republic, Denmark, Finland, France, Portugal, Spain, Sweden, Switzerland, United Kingdom	10
FC-	Full Cost Minus Discounts	Belgium, Germany, Italy, Hungary, Poland, Romania, Slovenia, Slovakia	8
FC	Full Cost	Estonia, Latvia, Lithuania, Netherlands (HS only)	3

In looking at the tariff system structure (the way tariff systems are implemented), tariff systems were classified into four categories: *Simple*, *Simple-Plus*, *Multiplicative* or *Additive*. A *Simple* system charges a base price per train-kilometer or per ton-kilometer, without considering any additional parameters. A *Simple-Plus* system may also include additional parameters and classifications of train characteristics. A multiplicative system is a product of the base price and various multiplicative factors that are considered in the final price. An additive system is a sum of multiple parts, where each part may be simple, multiplicative or calculated by another type of formula. Table 2 displays system classifications.

Table 2 – Tariff System Structure Types

System Type	Description	Countries	Quantity
Simple	price per train-km and/or per ton-km	Bulgaria, Denmark, Estonia, Finland, Ireland, Latvia, Lithuania, Netherlands, Norway, Portugal, Sweden	11
Simple+	same as "simple" with possibility of a few additional parameters	Austria, Hungary, Romania, Switzerland	4
Multiplicative	base price multiplied by different factors	Czech Republic, Germany, Poland	3
Additive	$X_1 + X_2 + X_3 + \ldots$ where X_i is a simple or complex component	Belgium, France, Greece, Italy, Luxembourg, Slovakia, Slovenia, Spain, United Kingdom	9

One of the reasons for classifying tariff systems into these four categories is to differentiate their complexity. Another – is to assess the ease of understanding of each tariff concept within the system. If in a *Simple* or a *Simple-Plus* system the origins of tariff concepts are usually easy to determine, a *Multiplicative* system does not have the same transparency, and origins of each multiplicative factor are not definitive. Just like a multiplicative system, an *Additive* system may contain multiplicative factors, making origins of IM costs difficult to determine and making it difficult to see a link between the system and IM costs.

While the majority of systems are classified as *Simple* or *Simple-Plus*, IMs from countries with high-speed lines in their network tend to have more complex *Multiplicative* or *Additive* systems (*Belgium*, *France*, *Germany*, *Italy*, *Spain*, *UK*).

Tariff System Concepts and Variables

In comparing different infrastructure tariff systems, tariff concepts are examined in each tariff system. All of the concepts have been classified into 8 variable categories, namely: Access, Capacity Reservation, Train Operations/Movement, Energy/Electricity, Maintenance, Safety/Security, Congestion, and Environment/Noise. Table 3 displays these categories, and classification on a per-country basis. Each check mark for each concept indicates that a country's infrastructure tariff system has infrastructure tariff system variables within that concept. The most-used concepts are train operation/movement (26), electricity (17), capacity reservation (14) and access (10) charges, respectively.

Table 3 – Summary of Tariff Concepts in Each Tariff System

Country	Access	Capacity Reservation	Train Operations/ Movement	Energy / Electricity	Maintenance	Safety / Security	Congestion	Environment
Austria (AT)			√				√	
Belgium (BE)	√		√	√				√
Bulgaria (BG)		√	√	√				
Czech Republic (CZ)		√	√	√				
Denmark (DK)	√[1]	√	√				√	√
Estonia (EE)			√					
Finland (FI)	√[1]		√					
France (FR)	√[1,2]	√	√	√				
Germany (DE)			√				√	
Greece (GR)		√		√	√			
Hungary (HU)		√	√					
Ireland (IE)		√	√	√				
Italy (IT)	√	√	√	√				
Latvia (LV)			√					
Lithuania (LT)			√	√				
Luxembourg (LU)		√	√	√			√	
Netherlands (NL)	√[1]		√	√			√	√
Norway (NO)	√[1]		√	√				
Poland (PL)			√					
Portugal (PT)			√	√				
Romania (RO)		√	√					
Slovakia (SK)		√	√	√				
Slovenia (SL)			√					
Spain (ES)	√	√	√	√		√		
Sweden (SE)	√[1]	√	√	√		√	√	
Switzerland (CH)			√	√	√	√		
United Kingdom (UK)	√	√	√	√			√	
Total	10	14	26	17	2	3	7	3

Notes:
1. Access fee for special infrastructure only (bridges, tunnels, special lines, etc.)
2. Access fee for regional service concessions

Tariff concepts can further be categorized into different variables that can be grouped into various categories and subcategories, including differentiation by infrastructure type, rolling stock type and characteristics, traction type (e.g. diesel vs. electric), service type (e.g. local vs. regional), path type and quality (e.g. normal vs. express), and others. A total of 48 variables are present in the 2012 infrastructure tariff systems. Most countries apply 6 to 13 variables, with Italy and Spain using the highest number, at 15 and 16, respectively.

Considering the changes from 2007, the quantity of variables added outnumbers the quantity of variables removed, and the overall tendency is to increase the number of variables in tariff systems. Between 2007 and 2012, most systems have been altered to some degree, with changes in the number and types of variables as well as change in infrastructure tariff levels. As a trend, many systems are becoming more complex in their structure with an increasing number of variables. In looking at how system parameters have evolved since 2007, some systems have been redesigned from scratch, while others have undergone modest to significant changes. Figure 1 summarizes these changes.

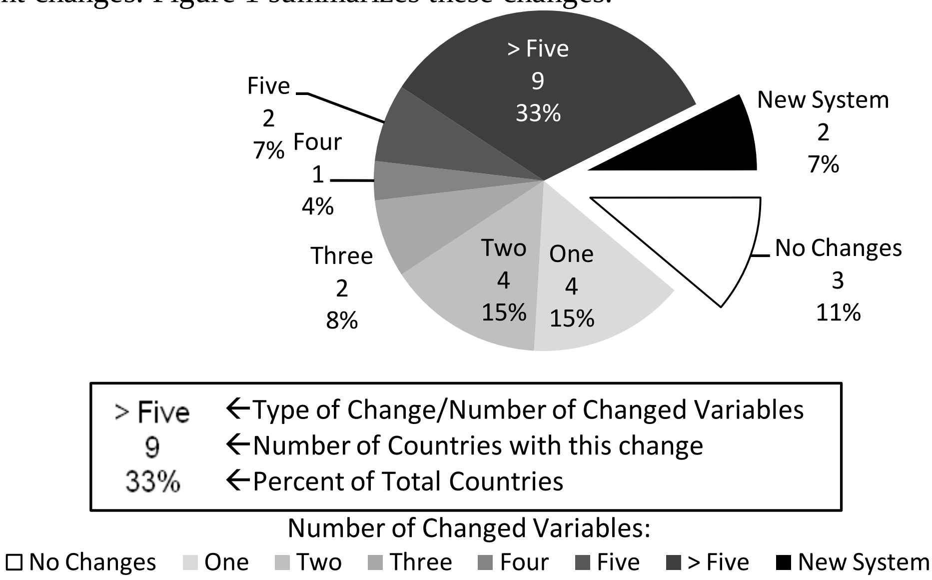

Figure 1 – Number of Changed Variables in Infrastructure Tariff Systems 2007-2012

Nearly 40% of countries have either seen significant changes in the structure of their existing infrastructure tariff system, or a new infrastructure tariff system altogether. Approximately half of the systems have seen some changes, and only 11% have seen no changes at all. These results point to a lack of tariff system stability, at least in the short term. Lack of tariff system stability in the long term can be problematic for RUs, as decisions about the acquisition and configuration of capital-intensive items with a long useful life, such as rolling stock, have much associated uncertainty due to lack of tariff system stability. No regulatory mechanisms exist to ensure that tariff system stability is present in the long term.

TARIFF LEVEL ANALYSIS FOR SELECTED ORIGIN-DESTINATION PAIRS

In this section, a quantitative analysis is performed, comparing tariff levels between all of the countries subject to the EU Directive 2001/14/EC. For this analysis, 27 Origin-Destination (OD) pairs, one per country, were selected. The selection was based on the following criteria: the OD pair should be as close to 300 km as possible, and should be located on a line with high speed service (existing or under construction). If none of those criteria could be met, then an OD with the best possible passenger service was selected in that country.

In calculating tariffs for this analysis, a 430-ton, 500-seat, 200-meter long high-speed train is considered, with operating parameters similar to those of the TGV Duplex. This train is used to calculate the usage fee for every one of the 27 OD pairs. It was assumed that the train stopped only at the Origin and Destination, and in cases where the tariff varied by time of day, four calculations were made and averaged to obtain an average rate between point A and point B: a train leaving A at 08:00, a train leaving B at 08:00, a train leaving A at 18:00 and a train leaving B at 18:00.

Table 4 shows the Origin-Destination pairs under consideration for this evaluation.

Table 4: Origin-Destination Pairs under Consideration

Country	Origin-Destination Pair	km
Austria (AT)	Vienna-Salzburg	312.62
Belgium (BE)	Brussels-Liege	104.52
Bulgaria (BG)	Sofia-Varna	543.58
Czech Republic (CZ)	Prague-Brno	253.82
Denmark (DK)	Copenhagen-Esbjerg	309.10
Estonia (EE)	Tallinn-Narva	209.41
France (FR)	Paris-Lyon	432.70
Finland (FI)	Helsinki-Turku	193.04
Germany (DE)	Frankfurt-Cologne	179.58
Greece (GR)	Athens-Thessaloniki	493.42
Hungary (HU)	Budapest-Debrecen	219.00
Ireland (IE)	Belfast-Dublin	182.00
Italy (IT)	Rome-Florence	261.03
Latvia (LV)	Riga-Rēzekne	224.00
Lithuania (LT)	Vilnius-Klaipeda	376.20
Luxembourg (LU)	Troisvierges - Bettembourg	34.60
Netherlands (NL)	Amsterdam-Breda	115.10
Norway (NO)	Oslo-Trondheim	551.81
Poland (PL)	Warsaw-Katowice	318.80
Portugal (PT)	Lisbon-Porto	336.10
Romania (RO)	Bucharest-Timisoara	533.10
Spain (ES)	Madrid-Seville	470.40
Sweden (SE)	Goteborg-Stockholm	457.00
Switzerland (CH)	Geneva-Lausanne-Bern-Zurich	279.42
Slovakia (SK)	Bratislava-Zilina	202.46
Slovenia (SL)	Ljubljana-Maribor	155.84
United Kingdom (UK)	London-Newcastle	432.00

The selected OD pairs provide the fastest or highest-quality service possible (e.g. high-speed service, flagship service between two major cities, etc.). While these ODs may not necessarily be representative of a country’s network as a whole, they compare the best possible passenger service that the country has to offer.

Per-kilometer fees shown in Figure 2 tend to vary between zero and 29.20 € per train-kilometer. Of the selected OD pairs, the highest per-kilometer fees can be observed on the high-speed lines in the Netherlands, France, Germany, Spain, and Belgium, while the lowest fees are on conventional lines in Estonia, Norway, Finland, Slovenia and Sweden.

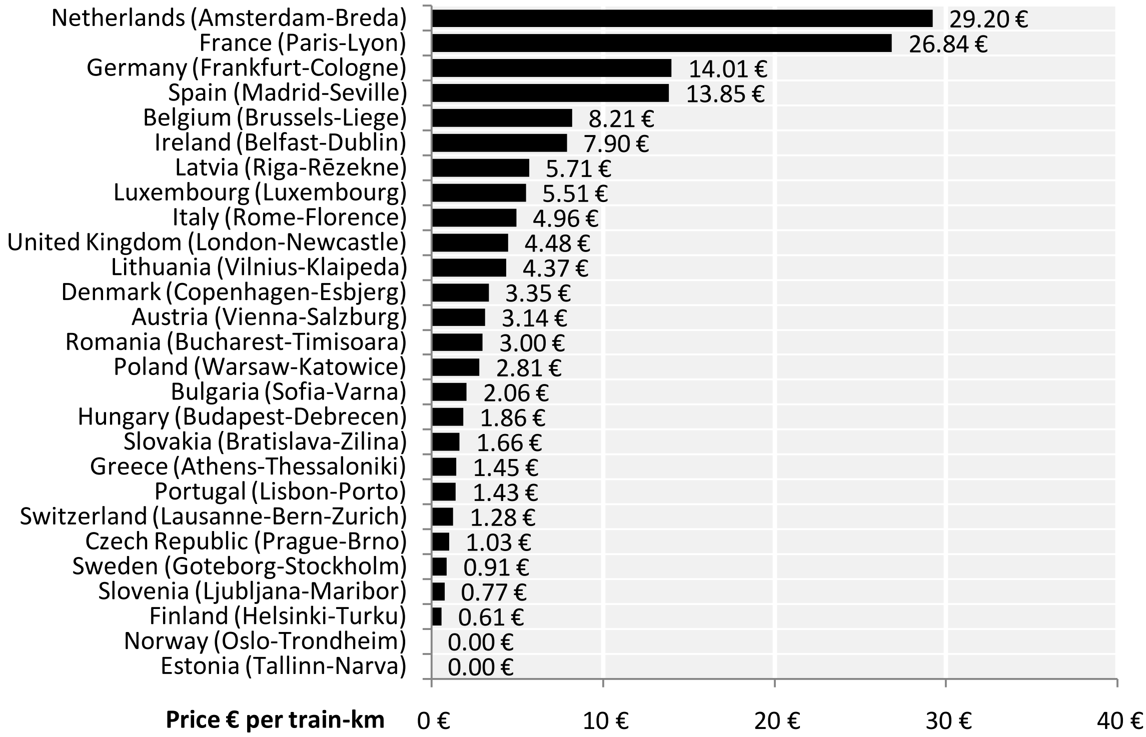

Figure 2 – Summary of Tariff Levels for Selected OD Pairs

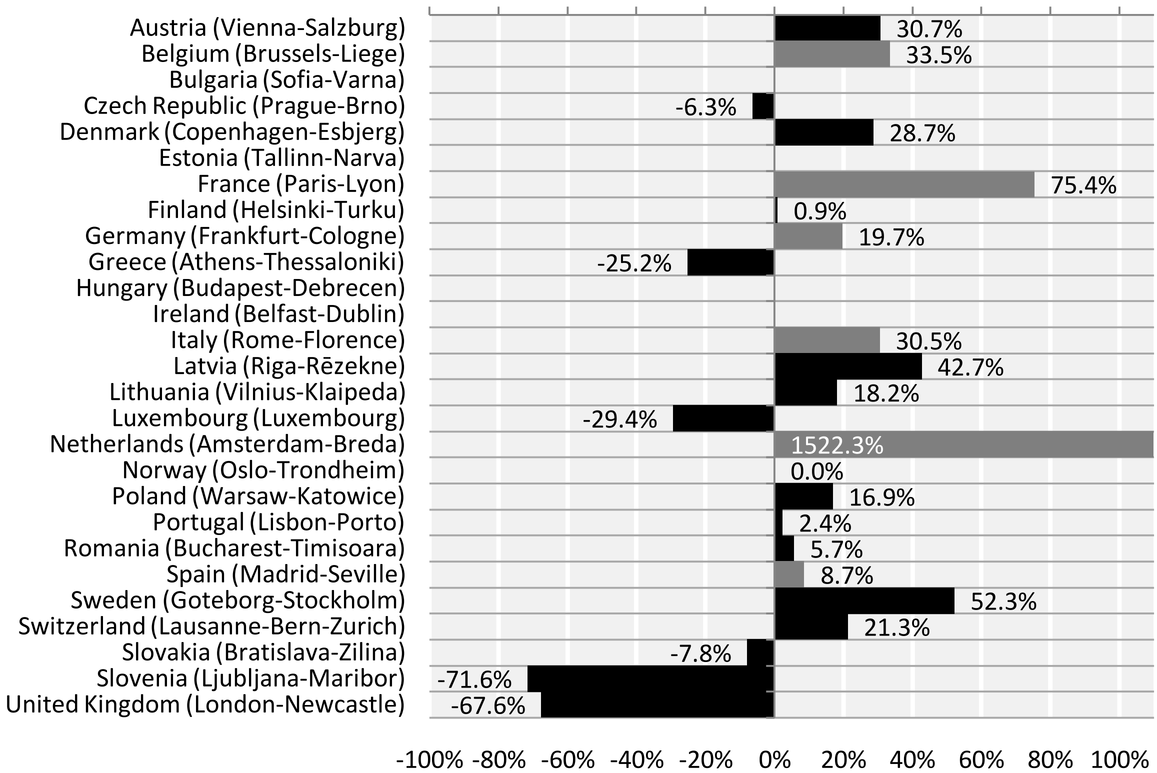

Figure 3 –Tariff Level Changes 2007 to 2012, high-speed lines in gray

Figure 3 shows changes in tariff levels between 2007 and 2012 for selected National OD pairs. No single trend emerges from changes in tariff levels between 2007 and 2012. In some cases, opening of new infrastructure (e.g. high-speed lines) resulted in a large increase in per-kilometer fees for certain OD pairs, while in other cases, a complete re-design of systems results in reductions of per-kilometer fees.

Changes vary between 0% for Norway and greater than 75% for France. A new tariff system for high-speed lines on a new high-speed line was introduced in the Netherlands, where the numbers from 2012 cannot be compared to those in 2007. At the same time, United Kingdom performed a periodic update to its system, resulting in a decrease in charges, while France now includes station charges, resulting in a large fee increase.

Infrastructure charge evolution can also be compared to the increase in the Consumer Price Index (CPI) as a means of evaluating real changes in infrastructure tariff levels in each country. Figure 4 compares the change in fees per year in each country (y axis) to the increase in average annual CPI (x axis). A black line shows a 1:1 increase in Fees vs. CPI.

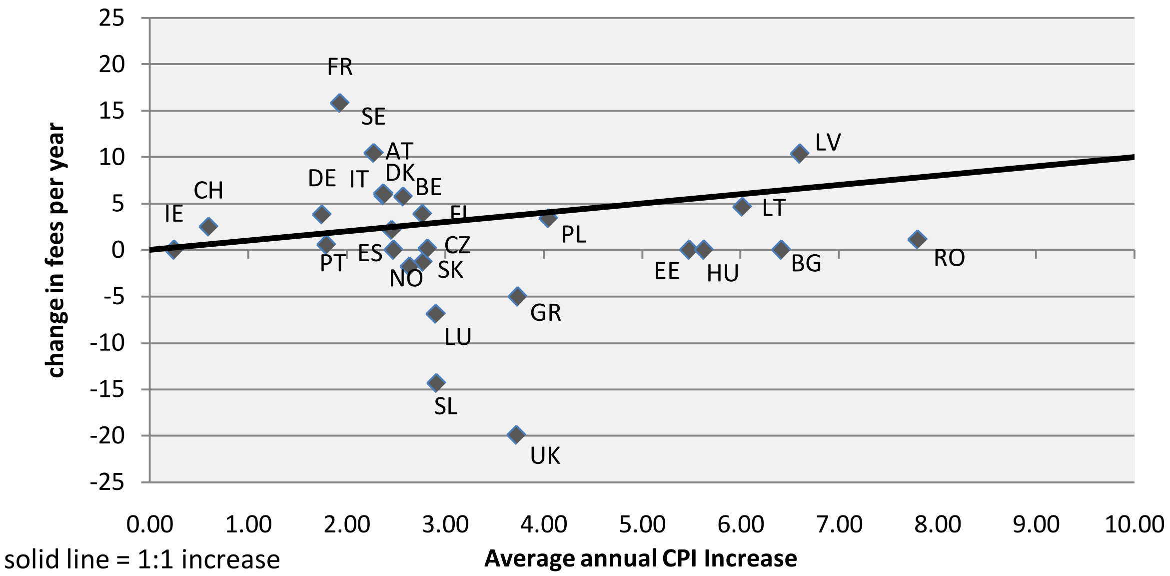

Figure 4 – Tariff Level Changes vs. CPI

The OD pairs above and below the line are split relatively evenly, with some line fees increasing faster than CPI, other line fees increasing slower than the CPI. In some cases, line fees decrease on an annual basis. It is interesting to note while most lines are clustered close to the 1:1 CPI line, some cases, such as France, have seen a rapid growth in infrastructure tariffs, compared to the CPI, while others, like the United Kingdom, have seen a decrease in infrastructure tariffs, compared to the CPI.

IMPACT OF INFRASTRUCTURE TARIFFS ON RU REVENUES

In order to assess the importance of infrastructure charges for RUs, a financial impact analysis is performed. Revenues from ticket sales are estimated in two ways: using a known full price of a ticket, and using real ticket price data, collected online through RUs' sales channels. For each of the two methodologies, the estimated revenue per train is then compared to the cost of running that train (the train's infrastructure tariff) over the line for each of the OD pairs, with the tariff calculated for each time period in question for the specific train being considered for that OD pair.

Methodology 1 considers the average ticket price to be 75% of half of the full price of a second class round-trip ticket. This method is better applicable to RUs that do not use yield management and a have low variation in ticket prices. The revenue calculated using this method is better considered to be an upper bound for the amount of revenue collected.

A 500-seat train considered previously, with 100% of seats allocated to second class and an average occupancy rate of 65%. Data collection involves recording the full published ticket price for each OD pair. In cases where a single tariff between the origin and the destination is not available (e.g. due to absence of direct services on that route), multiple parts were added together to obtain a full ticket price. If a service is not available for a particular OD pair, that pair is excluded from evaluation.

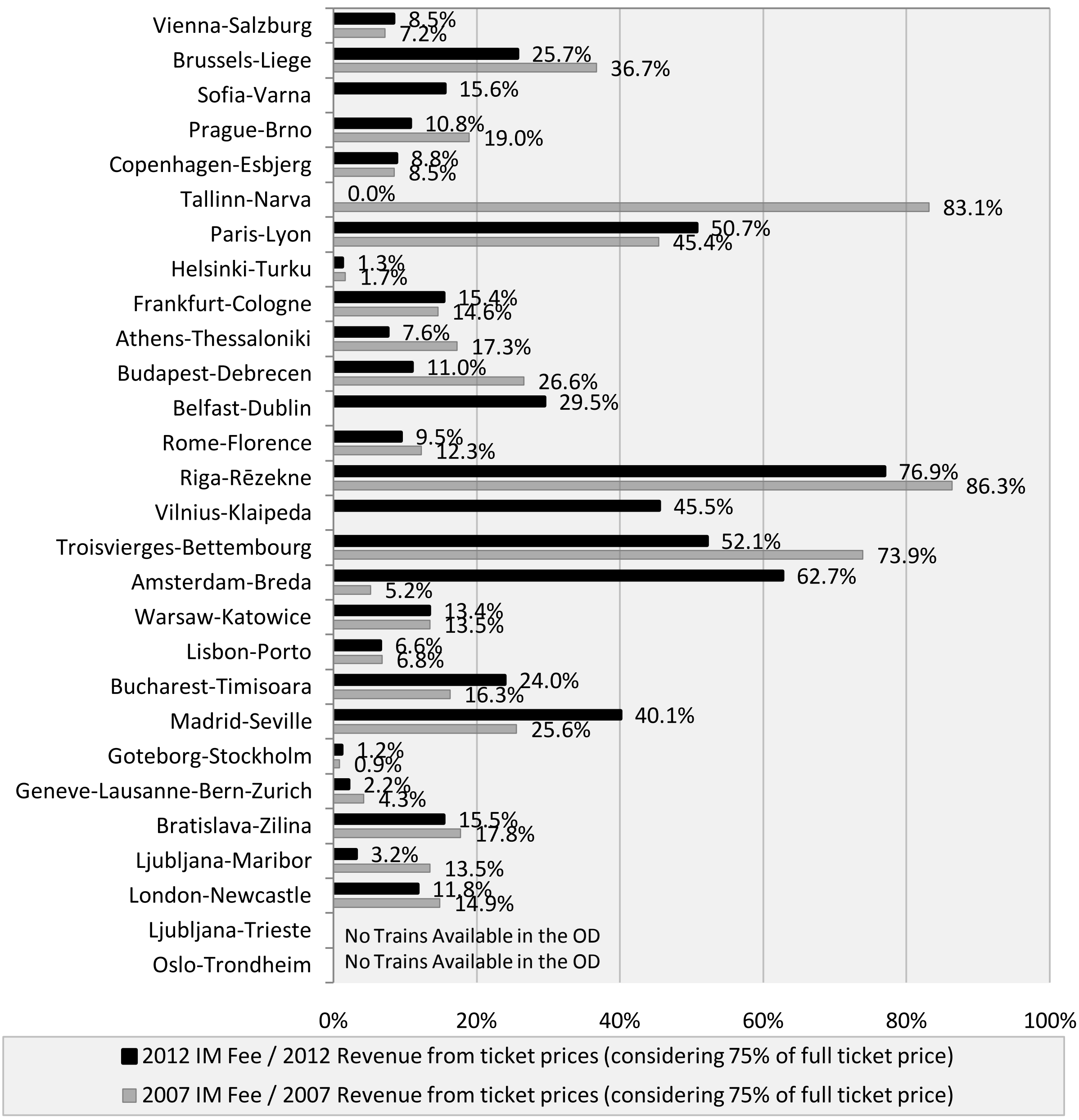

Figure 5: IM Charge vs. RU Revenue evaluation

In collecting ticket price data, the following criteria to choose route, service type and departure time were used (listed in the order used to break ties):

- Choice of route for each OD should be as closely related to the previously evaluated route as possible;
- The use of high-speed services is preferred to non-high-speed services;
- The number of transfers should be minimized;
- Fastest travel time is preferred;
- Day services are preferred to overnight services;
- Departure time in the morning is preferred to afternoon departure time.

Between 2007 and 2012, an increase in full ticket prices for most Origin-Destination pairs is observed. It should be noted that in cases where the ticket price decreased, a number of factors could be responsible for such a decrease.

Figure 5 compares the IM Fee to the RU revenue. Most of the resulting lines show a 10-20% rate for the IM Fee vs. Revenue ratio. For a few cases (Estonia and Latvia) the fee is above 75%. More importantly, however, for a number of high-speed lines this rate is above 40% and can reach as high as 55%. Compared to 2007, a general increasing trend of the weight of the IM fee on per-train revenues can be observed, although some decreases are also present.

A sensitivity analysis considered three train types: ICE 3 (DB), ETR500 (Trenitalia) and TGV Duplex (SNCF). In all cases, the IM Fee/Revenue was higher for ICE3 than for the base 500-seat train, the ratio for the TGV Duplex was slightly lower than the base 500-seat train, and the ratio for the ETR500 was significantly lower than that of the base 500-seat train.

For ODs that pass through a country with a tariff system that considers seats or seat-kilometers, the results are different than for tariff systems that do not consider seats, due to both the revenue aspect (higher capacity trains generate more revenue) and the costs associated with using a higher-capacity train (the tariff system charges higher cost for higher-capacity trains).

Methodology 2 considers data, collected through each RU's website sales channel. This method involves collecting data over a three week period and considers only those ODs, where RUs use variable ticket pricing in selling tickets.

The data was collected over a five-day period, once per day. Each day, the readings were done for a Wednesday and Friday of the following week, for 3 time periods (AM: 07:00-09:00, Midday: 11:00-13:00, and PM: 17:00-19:00) for first and second class tickets. The cheapest price was recorded for each of these time periods, for a total of 30 data points per week, 90 data points over the data collection period per OD per direction for first class, and 90 data points per OD per direction for second class. In calculating the revenue, a fixed average load factor of 70% was considered, with the remaining seats allocated to first class, to obtain an average train occupancy of 65%.

For this methodology, tariffs are calculated for a specific train type (weight, seats, length) that operates on each OD pair during the specific time period (AM Peak, midday PM Peak). Table 5 shows the applicable information about the train considered for each OD pair.

Table 5: Information about trains and seat arrangement for revenue evaluation (Methodology 2)

Origin-Destination Pair	Train Type	Train Length (m)	Train Mass (ton)	Seats		Assumed Occupancy Rate		
				2nd Class	1st Class	2nd Class	1st Class	Avg
Brussels-Cologne	ICE 3M	200	409	337	93	70%	47%	65%
Hannover-Berlin	ICE 3	200	435	343	98	70%	48%	65%
Frankfurt-Cologne	ICE 3	200	435	343	98	70%	48%	65%
Madrid-Zaragoza	S-103 (AVE)	200	425	264	140	70%	56%	65%
Madrid-Barcelona	S-103 (AVE)	200	425	264	140	70%	56%	65%
Madrid-Seville	S-112 (AVE)	200	322	203	115	70%	56%	65%
Rome-Naples	ETR500	330	598	461	195	70%	53%	65%
Firenze-Milano	ETR500	330	598	461	195	70%	53%	65%
Rome-Florence	ETR500	330	598	461	195	70%	53%	65%
Paris-Lille	TGV (Réseau)	200	383	259	118	70%	54%	65%
Lyon-Marseille	TGV (Duplex)	200	380	330	182	70%	56%	65%
Paris-Bordeaux	TGV (Atlantique)	240	444	369	116	70%	49%	65%
Paris-Marseille	TGV (Duplex)	200	380	330	182	70%	56%	65%
Paris-Lyon	TGV (Duplex)	200	380	330	182	70%	56%	65%
Paris-Amsterdam	Thalys PBA	200	385	257	120	70%	54%	65%
Paris-Geneva	TGV PSE Lyria	200	385	240	110	70%	54%	65%
Manchester-Birmingham	220 (C.C.)	95	186	162	26	70%	34%	65%
London-Brussels	Eurostar	395	752	544	206	70%	52%	65%
Amsterdam-Brussels	Thalys PBA	200	385	257	120	70%	54%	65%

Source: Train Data – World High Speed Rolling Stock (UIC), Renfe, Thalys, Trenitalia, SNCF, DB, Eurostar

In estimating ticket prices using *Methodology 2* (data collection from RUs' Internet sales channels), an average ticket price was obtained for first and second class tickets, for each time period on Wednesday and Friday during the three-week data collection period. Per-train revenue was then calculated by multiplying the revenue per seat by the average occupancy. On the IM side, revenues were calculated for each Origin-Destination pair and compared, based on the most typical train, running on each line. Finally, IM fees were compared to ticket prices for each time period, and also a weighted average value of IM fees to RU revenues was developed.

Figure 6 shows a box plot for the collected ticket price data for second class services. The highest dispersion is observed between London and Brussels, through the English Channel Tunnel, while the lowest dispersion was observed on most Italian lines. The highest ticket price was also observed on the English Channel Tunnel service between London and Brussels, while the lowest ticket price was recorded on the Manchester-Birmingham OD.

Table 6 shows a comparison between IM Fees and RU Revenues during different time periods for Wednesday and Friday, 2 data collection days. As in some cases infrastructure tariffs that IMs charge vary between different time periods throughout the day, one could expect a similar difference to occur in ticket prices, thus maintaining the ratio constant. While in Germany that proved to be the case, French lines show the most variability with the ratio.

Based on results from this methodology, infrastructure tariffs that IMs levy on RUs play a significant part in RUs' operating budget, in some cases topping 35%.

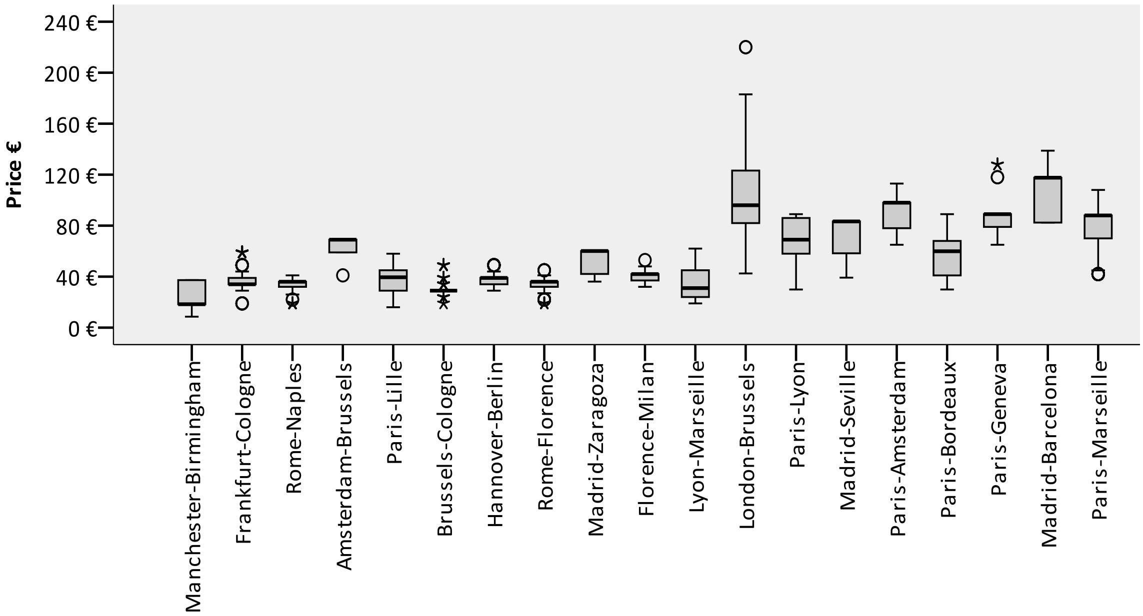

Figure 6: Box plot of collected variable ticket prices (2nd class)

Table 6: IM Fee vs. RU Revenue (Methodology 2 – variable ticket prices)

Origin-Destination Pair	IM Fee / RU Revenue per train (Wednesday)			IM Fee / RU Revenue per train (Friday)		
	AM	Midday	PM	AM	Midday	PM
Brussels-Cologne	10%	9%	9%	9%	8%	8%
Hannover-Berlin	10%	10%	9%	10%	10%	8%
Frankfurt-Cologne	12%	15%	12%	14%	14%	14%
Madrid-Zaragoza	17%	16%	15%	20%	14%	14%
Madrid-Barcelona	17%	15%	15%	19%	13%	15%
Madrid-Seville	20%	18%	18%	21%	16%	16%
Rome-Naples	7%	7%	7%	8%	7%	7%
Firenze-Milano	10%	10%	10%	9%	9%	9%
Rome-Florence	7%	6%	7%	7%	6%	5%
Paris-Lille	33%	29%	34%	46%	38%	33%
Lyon-Marseille	32%	26%	26%	29%	22%	17%
Paris-Bordeaux	34%	26%	38%	31%	21%	24%
Paris-Marseille	36%	39%	32%	42%	27%	31%
Paris-Lyon	26%	38%	23%	35%	29%	25%
Paris-Amsterdam	32%	29%	30%	28%	24%	27%
Paris-Geneva	30%	24%	30%	32%	25%	30%
Manchester-Birmingham	9%	18%	16%	10%	18%	13%
London-Brussels	38%	40%	31%	34%	27%	26%
Amsterdam-Brussels	16%	17%	16%	17%	16%	17%

A comparison of the two methodologies in Figure 7 shows that Methodology 1 provides an overall higher ratio of IM Fees to RU Revenue than Methodology 2, and both evaluations show the importance of IM Fees (Infrastructure Tariff Charges) to the Railway Undertakings.

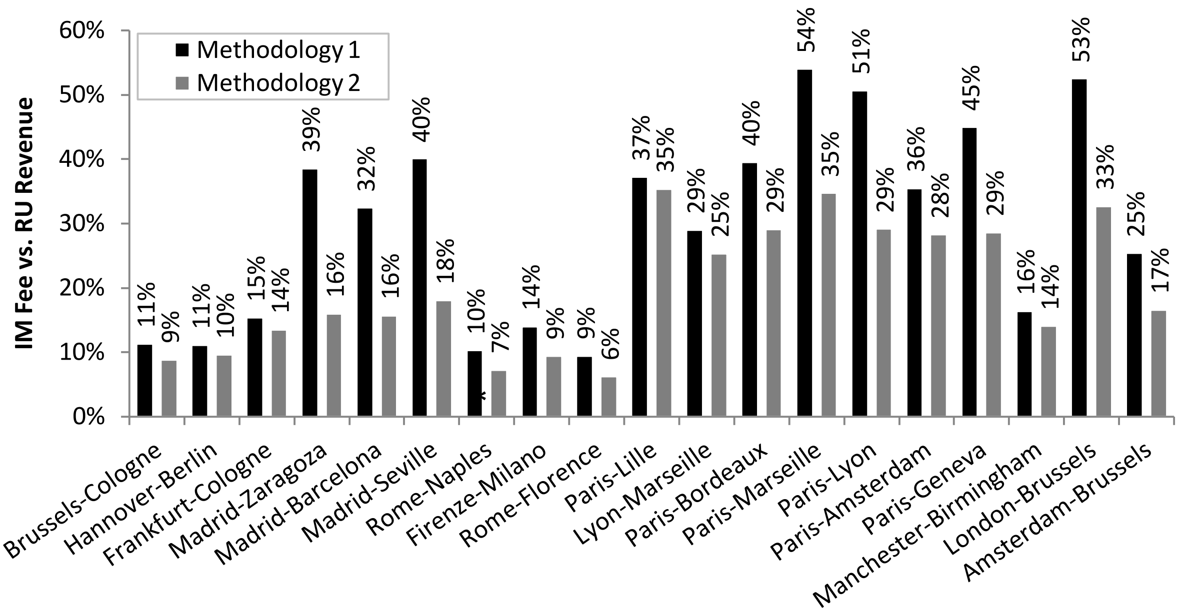

Figure 7: IM Fee vs. RU Revenue evaluation: comparison of Methodology 1 (fixed prices) and Methodology 2 (variable prices)

IMPACT OF INFRASTRUCTURE TARIFF ON IM REVENUES

Having examined the impact of IM fees on RUs, a financial analysis of IM Revenues will not be performed. First, high-speed line revenue will be estimated using real traffic data and real tariffs. This will provide revenue numbers and a starting point for evaluating the cost recovery potential for each of the selected high-speed lines. Finally, looking at high-speed lines in different countries, investment costs and revenue will be compared.

Analysis of IM Revenues for Selected HS Lines

Traffic data was collected for each line of the same subset of lines, considered for Methodology 2, using a typical weekday in March 2012. For each line, trains were counted both if they used the full line or only a part of a line. Respective IM fees were calculated and typical daily revenue figures were obtained for each line.

In collecting traffic data, each train service type was counted separately. In tariff systems where trains are differentiated by time of day, a single time period was assigned to the train. If a change between time periods occurred during a train's journey, the train was assigned the time period in which it spent the most time in.

Figure 8 shows the traffic data collection results. For services that do not operate the entire length of the line, a number of Train Equivalents was calculated only for the purposes of this chart. For a train that does not travel the entire length of the line, its Train Equivalent is considered to be the percentage of the length of the line that the train travels on. For example, a train travelling 80% of the line is counted as 0.8 of a train. After summing the total number of trains, the resulting value is rounded up to the nearest whole number.

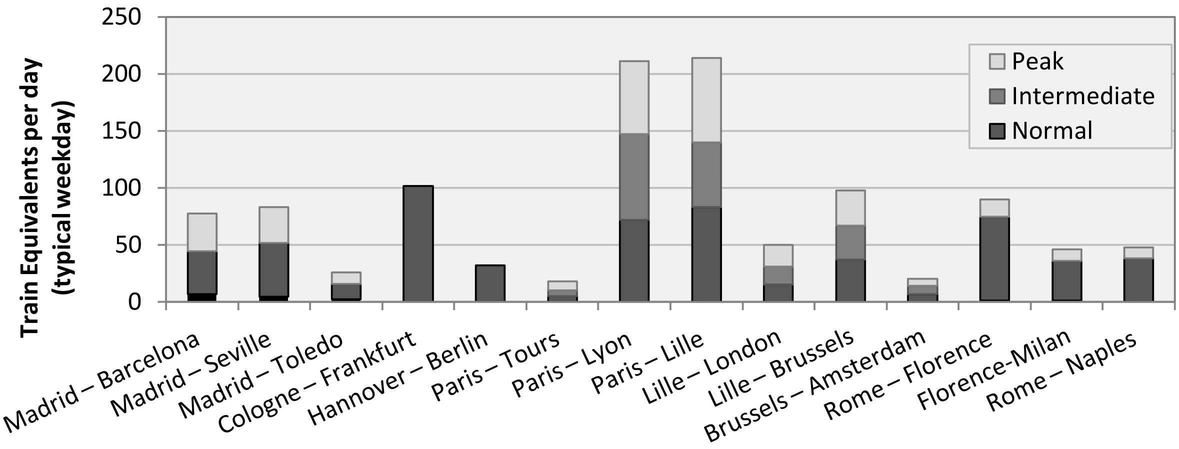

Figure 8: Daily Traffic

Next, revenues per train are multiplied by the number of trains on each line. This number is then converted into an annual number using 350 days per year (to account for reduced service on weekends and holidays). Figure 9 shows the resulting net revenue (in M€) before maintenance costs are taken into account. Again, all lines have healthy positive net revenue.

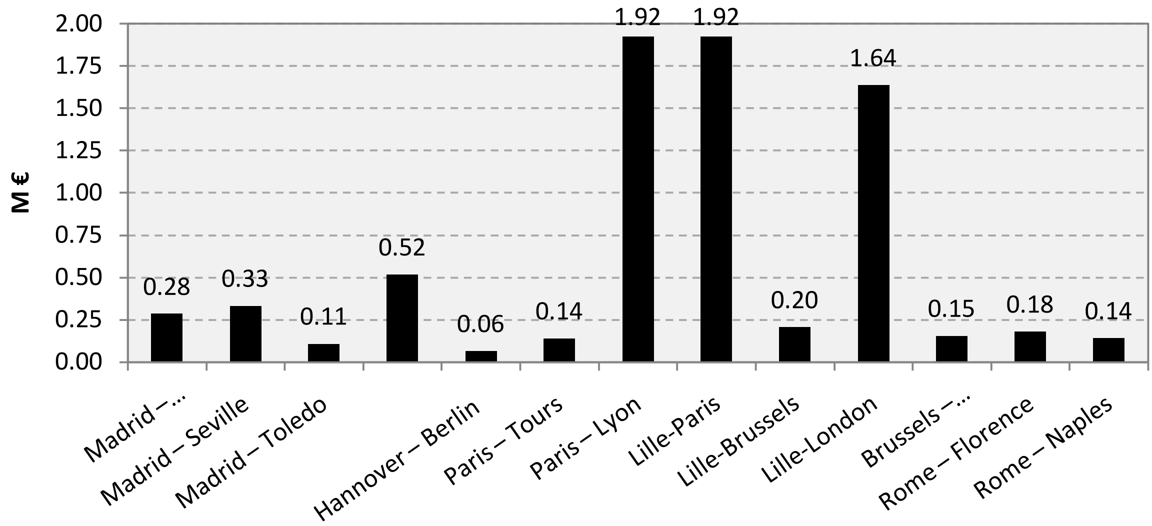

Figure 9: Estimated Net IM Revenues per Kilometer in M €, before maintenance costs

Investment Cost Recovery Figures

In approaching the question of line profitability, IM revenue is estimated and compared to maintenance costs and initial investment costs. First, IM revenue is estimated by calculating the infrastructure fee, paid by a typical train for every time period (if the tariff system has a time-dependent component). Second, traffic data for a typical day is collected using official timetables. Third, the revenue for a line is estimated, by multiplying the traffic in each time period by the fee for each time period. Next, this daily revenue is scaled to an annual number, and it is compared to maintenance costs and initial investment costs.

In considering annual line maintenance costs, a value of 0.08 M€ per train-kilometer, a usual proxy for typical high-speed ballasted lines (Lopez-Pita et al., 2008) is considered. Net revenues are found to be positive for all lines, except for the line between Hannover and Berlin, which does not take into account freight traffic that shares the line with passenger services. This, in turn, means that each line is able to cover maintenance costs.

Next, in order to examine cost recovery of initial investment costs, the net IM revenues are compared to hypothetical cost for constructing a new high-speed line. These costs are estimated to be 15 M€, with sensitivity analyses at 10 M€ and 20 M€. For this analysis, maintenance costs (excluding renewal) of 0.08 M€ per line-km are assumed.

Table 7: Estimated Initial Cost Recovery per Kilometer (after maintenance costs)

Line	km	Net Annual Revenue in 2012 as a % of Initial Investment Costs (15M € per line-km)
Madrid – Barcelona	621	1.35%
Madrid – Seville	472	1.67%
Madrid – Toledo	21	0.18%
Cologne – Frankfurt	174	2.91%
Hannover – Berlin (*)	255	-0.11%
Paris – Tours	243	0.38%
Paris – Lyon	409	12.29%
Lille-Paris	214	12.29%
Lille-Brussels	101	0.83%
Lille-London	279	10.37%
Brussels – Amsterdam (NL part only)	125	1.02%
Rome – Florence	261	0.65%
Rome – Naples	205	0.39%
Note: (*) Hannover – Berlin does not consider freight traffic		

Table 7 shows resulting cost coverage per year, given the traffic assumptions for 2012. As traffic over the life span of line varies significantly it is difficult to assess how long it would take to cover costs for a line that has not yet paid for itself. However an indicator, showing cost coverage in a specific year is a good evaluation of the state of a particular line.

Some lines, such as Paris-Lyon, have recovered their initial investment costs more than once. Yet, tariff levels remain high for these lines. Directive 2001/14/EC is clear in that an IM may not charge more than a line’s full cost, nor may an IM cross-subsidize some lines, using revenue from other lines.

Cost Recovery Figures for International High-Speed Lines – A need for Homogenization?

A question that naturally comes up in evaluating international lines is whether some type of homogenization in cost recovery figures is needed. When neighboring countries invest similar amounts in infrastructure, should they be allowed to have different charging philosophies and tariff levels? An example of this can be seen for the London to Brussels OD pair. Two comparisons of infrastructure charges for a hypothetical 500-seat, 430-ton, 200-meter long train can be made: one including the Eurotunnel, and another excluding it. The case that includes the Eurotunnel greatly increases the average and skews it upwards. Both cases are shown in Figure 10.

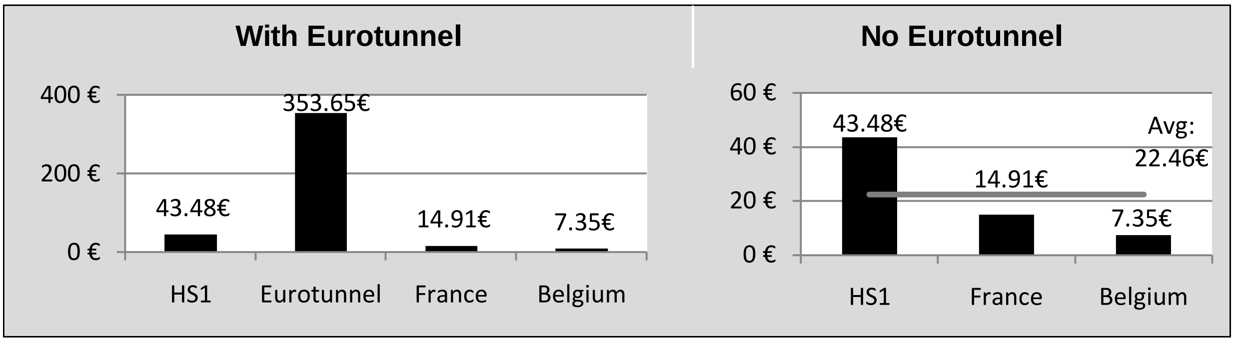

Figure 10: Costs € per km for a 500-seat, 430-ton, 200m long train travelling between London and Brussels

For similar infrastructure, the fee in France is close to double that of Belgium, and the fee in the UK is close to double that of France. Cost recovery figures along these segments also vary greatly (as mentioned before in Table 7). These differences create virtual barriers for RUs in operating international services, just as technical barriers are lifted with the introduction of common electrification and signaling systems for high-speed services.

As the European market is opened to competition between RUs, and as more international high-speed services begin operating, this question of equitable infrastructure cost recovery for IMs and harmonized tariffs for RUs will need to be addressed.

CONCLUSIONS

The qualitative changes show that while simple systems have remained simple, the number of complex systems has slightly increased and the complex systems have become more complex. The overall number and types of variables has remained similar to those in 2007, with some minor changes, however at least half of infrastructure tariff systems have undergone significant changes or have been redesigned altogether.

Changes between 2007 and 2012 also show that the dispersion in tariff systems has increased in both the structure and levels. Infrastructure tariff levels have generally increased for high-speed lines, but have remained the same or experienced a decreasing trend for conventional lines. When compared with CPI, of the 27 evaluated countries, the number of countries increasing faster than the CPI is about the same as the number of countries decreasing or increasing slower than the CPI. While every high-speed line has increased since 2007, the level of increase varies from line to line.

In considering the two approaches to estimating revenue, the approach that considers fixed ticket prices provides a good opportunity to see the maximum possible estimate for revenues given the existing assumptions of this analysis. The approach that considers real ticket prices provides a revenue estimate that is closer to reality. Using the second approach, ticket prices for high-speed lines tend have more variability and spread in cost, while tickets for conventional lines are closer to the data collected using the first approach.

The relationship between IM Fees and RU revenues is not clear cut. In comparing IM fees to RU revenues, it is clear that IM fees play an important role in RUs' operating costs. While the revenue for high-speed lines tends to be high, tariffs tend to play an even bigger role than for most conventional lines. Most ODs have seen an increase of the relationship between IM fees and RU revenues (indicating higher fees and/or lower ticket prices), however some lines have seen a decrease in the percentage of fees on total RU revenue. While there have been some fluctuations, the percentage remains similar for conventional lines and has increased significantly for high-speed lines.

From the analyzed data, it is clear that most lines can safely recover maintenance costs. In examining the relationship between IM costs and IM revenues, from the data recovered the IMs seem to be able to recover a non-negligible portion of initial investment costs for most high-speed lines. In some cases this amount can be very significant.

Finally, given the disparity in infrastructure tariff levels, and similar investment costs in railway infrastructure, a question of whether more European regulation is needed to promote equity in infrastructure investment remains an open one.

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