Rail Infrastructure Charging in The European Union

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Abstract

This paper analyses the requirements for rail infrastructure charging, laid down in directive 2001/14/EC. It calls for marginal cost pricing and allows for mark-ups. Four standard pricing principles are analyzed on their suitability for track charging. It is found that no charging system proves superior and that the EC legislation is not opposed to economic theory. Scrutinizing the tariff systems of the EU member states, it is found that not all accomplish this directive and information are gained for the development of tariff systems.

1 Introduction

Infrastructure pricing is a long established and controversial issue of European transport politics. The different approaches, that the European Commission has chosen over the years, reflects the heterogeneity of opinions across the member states, within the scientific community and among practitioners. The current trend towards marginal cost pricing for transport infrastructure for instance does not meet the suggestions of cost recovery aims as recognized in the Green Paper "Towards Fair and Efficient Pricing in Transport". The recent policy in the pricing of railway infrastructure is ambiguous in this respect. In directive 2001/14/EC, the general claim is the establishing of marginal cost pricing. But deviations are allowed for in the form of mark-ups on these costs.

The aim of this paper is threefold. The requirements for the charging the track use, laid down in the above mentioned directive, are analyzed. This is done by comparing them with standard tariff systems, which are usually deployed for transport infrastructure. In order to come to a conclusion, these standard tariff systems are evaluated, considering their effect on efficiency. The European Union member states were required to turn the claims of directive 2001/14/EC into national law by March 15, 2003. A second objective of this paper is therefore, to see if the charges in the member states are in line with this requirement and then suggestions of economic theory[1]. Furthermore, they are scrutinized to find useful elements to improve existing tariff systems and create new ones. This is the third objective of this article.

This paper concentrates on the access to the main facilities and their charges. The pricing for the use of the so-called service facilities in Annex II of directive 2001/14/EC is not considered. Hylen provides an insight into the access and charges of these facilities in five European countries (Hylen, 2001).

The structure of the article is as follows: The background is described in chapter two by describing the cost components of the rail infrastructure and different principles of setting prices. These principles are then evaluated. In chapter three, the existing rail track charges of European Union member states are analyzed on the basis of the previous chapter. In the fourth

[1] Infrastructure charging in Switzerland is considered, although the country is no member state of the European Union. This exemption is made because Switzerland obtains a crucial geographical position in the European rail network.

chapter, recommendations for the creation and the amending of tariff systems are given, the last chapter concludes.

2 Rail Infrastructure Charging

The nature of rail infrastructure as a natural monopoly, the large amount of sunk costs among the assets and missing intermodal competition in at least some market segments raise the need to regulate the sector. The public influence on the rail network is usually of a severe kind, leading to a public ownership of the infrastructure in nearly all European countries. The legislation of the European Commission refuses - with good reasons - to require a specific a organisational structure and ownership of the infrastructure manager (IM). However, some conditions concerning open access, the price setting and slot allocation procedures have been laid down, but leave plenty of freedom for the national governments and the respective IMs. As this paper examines the directive 2001/14/EC and its accomplishment across the EU15, it follows the framework of this directive. It abstracts from the organisation of the IM, focussing solely on the system of charges. The existing price systems are judged and recommendations are given without considering any regulatory framework. This limits the possibilities of evaluation, as the aim of welfare maximization does not only depend on the price system. The individual situation in each country, e.g. an integrated incumbent, requires further analyzes, which is beyond the scope of this paper.

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 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. In the latter case, the discount schemes have to be available for all users of this section.

This chapter describes in a general form the cost components of the rail infrastructure (section 2.1)and turns then to standard pricing principles. They are analyzed (section 2.3) with respect to their ability to ensure allocative efficiency and further aims, described in section 2.2. The outcome of section 2.3 is a pricing principle which should be preferred for rail infrastructure. Finally, it is concluded, whether the requirements of directive 2001/14/EC match the features of this “best standard pricing principle”.

2.1 Cost Components of Rail Infrastructure

Railway infrastructure is used as an input for different services. Freight trains and passenger trains operate on it and further differentiations can be made within these market segments, as for instance single wagon load transport incurs costs and attracts demand different from trainload transport. These services – whether they are provided inside an integrated company or over the borders of two enterprises - partly share the same infrastructure, e.g. the trackbed. Certain features of the infrastructure might be shared by one or more, but not all, services, thus generating **blockwise variable costs**. E.g. only electric trains make use of the power supply facilities, diesel trains don't account for the costs generated by the wires etc. Indeed, the enforcement of the trackbed for an axle-load above 22.5 t could be assigned to specific operators. These costs, once identified, are common only for the operators which transport heavy weights. Other costs, which are entirely common to all operators, cannot be traced to any particular service or group of services. Thus, the costs of the slot provision depend not only on the traffic volume (q), but also on the characteristics of the infrastructure (z) and the suprastructure (v). The **cost function** can be described as (Rothengatter, 2003, 126)

$$\mathbf{C\ (z,q,v) = F_1\ (z,q,v) + F_2\ (z,q,v) + c(z,q,v)}$$

Where C denotes the total costs, F_1 the blockwise common costs, F_2 the common fixed costs and c the variable costs. The proportions of F_1 and F_2 change over time. The difficulties of charging systems result from allocating the common costs and the blockwise variable costs to the operators, as their nature prevents them from being distributed in an impartial way. Once the blockwise variable costs are identified, the problem is reduced, as they are to be distributed only between the member of the user group at stake, which is still difficult. The problem is aggravated by the high proportion of these costs – they account for up to 80 - 90 % of the total social costs of the rail infrastructure (Hylén, 2000, 2). This proportion applies if a short planning horizon is chosen, as done by EU legislation. The remaining short run marginal costs (SRMC) change with every further movement and can be attributed directly to a particular operator. Their determination requires detailed cost studies, which can comprise a variety of elements:

- Operating costs, that can be traced to a particular train movement, e.g. for personnel and signalling,
- Wear and tear costs for maintenance and renewal of the infrastructure,
- Costs for energy consumption (electricity or diesel), and
- Additional timetable planning and administration costs.

If SRMC consider ecological costs, impacts on congestion, on the noise level and accident costs of other parties, they are referred to as **short run marginal social costs** (SRMSC). An additional externality, which currently attracts attention, is the influence of rail transport on global warming. The specification of the relevant cost curves, which are necessary to establish equilibrium prices, is problematic. Although there is no European IM deploying a perfect SRMSC-pricing scheme, remarkable examples exist, notably in Scandinavian countries, covering some of the above mentioned components (see Thomas, 2002). Marginal cost studies were also carried out in Austria and the UK. Most of these studies cover at least the wear and tear costs. Other components are of a less relevant proportion, like accident costs, which are moreover likely to be covered by insurance costs. Further marginal costs are rather easy to identify, e.g. the energy consumption costs, although meters on the traction vehicles are required.

Scientific attention is recently paid to the **capacity costs**. These are usually considered to be composed of (Nash, 2003, 6):

- Congestion costs, and
- Scarcity Costs: opportunity costs of train operator B, which cannot run a train as they wish, because the slot has been given to operator A.

The expected congestion costs only occur on track sections with dense traffic, where it is more difficult for the IM to manage reactionary delays. They consist of the costs of time and energy imposed on other users of the network. If the infrastructure investment is done optimally, the revenues from an optimal congestion charge will cover the deficit that is otherwise incurred (Mohring & Harwitz, 1962). This finding only holds if there are constant returns to scale, which is usually not found to be the case for railway infrastructure. Operators should consider these congestion costs in the process of timetabling. They are likely to influence the track choice if relatively high. The congestion costs can be estimated ex ante by means of models (on the basis of historic data) and assigned to the operators (Nash, 2003, 3). Congestion costs have to be considered separately from the **disruption costs**, which are incurred by vehicle breakdowns etc. The latter should be treated ex post, as it is done in the UK and the Netherlands, on the basis of costs imposed to other operators.

Scarcity costs are opportunity costs and stand outside the systematic of marginal costs. In a perfect competitive market, they are identical with the price of a product and cover the marginal costs of the production. If the scarcity costs are high, e.g. in a bottleneck, they may exceed the marginal social costs, if properly priced. If the latter are accounted for separately, the prices for the slots are going to be too high, leading to misallocations. Pricing of scarcity ensures that the service with the highest value gets the slot and is therefore most important for the timetabling and the slot allocation during operation. It has to be answered as well for the adjustment of schedules in long-term franchises. The basic problem is that scarcity generally only appears on particular sections of the network, where a number of trains want to pass at particular times, serving different relations. Even if the capacity is only scarce for the particular section, the value of the complete train runs at stake have to be considered in allocating the slot. The problem is independent from the organisation structure as integrated railways have to decide as well, how to distribute capacities (freight trains, local trains, …) in bottlenecks. If there is a possibility to charge for scarcity on the tracks, it has to be ensured, that the revenue generated is invested in infrastructure enhancement. To date, this question is solved in all EU15 countries by priority rules, which are likely to be accompanied by mediation in practice. As these priorities do not guarantee a welfare maximizing capacity allocation, new approaches are currently examined, e.g. second-hand trading (see Nash, 2002, 5), auctions (see Cox, 2002), prices on the basis of long-term marginal costs (see Hylen, 1998) and definition of standard paths for each bottleneck if capacity has already been assigned (see Nash et al, 2003).

2.2 Economic Objectives of Rail Infrastructure Charges

In neo-classical markets, the price mechanism clears supply and demand of scarce resources. However likely a perfect competition in general may be, it certainly does not exist in the case of the rail infrastructure supply. The main obstacles for competition is the nature of the rail infrastructure as a natural monopoly. Together with a high proportion of fixed costs and a lack of intermodal competition in wide parts of the market, this leads to the need of regulation. In all of the EU-member states governments influence the prices of the rail infrastructure slots, either in form of internal regulation or (direct or indirect) price regulation. In doing so, two economic aims of prices are to be considered:

Allocative Efficiency (static)

A price is allocative efficient, if it maximizes the social welfare. This is the case, if the price of a slot equals the marginal social costs respectively. It leads - in a static perspective - to the number of slots that the operators require to meet the demand of the final customers.

Allocative Efficiency (dynamic)

In order to maximize social welfare in a dynamic perspective, the prices for slots have to deliver signals for investment and disinvestment. Capacities and services should be increased, where they create benefits greater than the costs. This refers to both the supply- and the demand side. The IM should have the incentives to build new lines, close the ones which generate too little revenue, or to deploy a new technology. The operators have to rely on the price system to adjust their fleet to use the capacity in an optimal way. This might for example lead to the replacement of cost-intensive high speed trains by slower vehicles. In order to create incentives for (dis)investment, it is crucial that a pricing systems reflects the variable costs and the blockwise variable costs and links them to the respective user groups (Rothengatter, 2003, 126). A pricing system has to take account not only of the volume of transport and the infrastructure characteristics, but also of the suprastructure characteristics.

Further conditions should be considered in the setting up of a pricing system. **Transparency** ensures that the RU know what they pay for and allows to calculate different alternatives - a vital element of each commercial undertaking. Moreover, it helps the mutual understanding of the parties. If they know the elements of the price and what drives them, they have the ground to predict future changes. Moreover, the prices should ensure a high degree of **equivalence** between the ones who benefit from the slots and the ones who bear the costs of their provision. This claim, which leads to cost-recovery considerations, is not based on welfare economic, but on the democratic principle. It can be ruled out by economic reasons. Finally, **transactions costs** should be considered while defining the prices for the slots, the allocation procedures and the funding of the IM. This includes the way in which the costs are covered and the transaction costs entailed.

A good price system should not only incentivise the IM to provide the right amount of slots in the right quality. It should also lead to a minimal use of inputs in the production process and to choose the cost minimizing technology. Unlike in perfectly competitive markets, **technical efficiency** is not achieved automatically in the rail sector. A regulation regime that sets the prices exactly according to a proportion of the costs, will lead the IM to technical inefficiency, as he has no incentive for cost-reductions. The degree of technical efficiency, that the IM realizes, cannot be predicted without the respective regulatory framework, therefore it is not considered in this paper. The same applies for quality. A monopolist will not offer its products in the optimal **quality**. It needs to be adjusted by the overall regulatory framework for the IM. The price (for punctuality, rolling stock condition, …) provides certainly a good incentive. There are good reasons to adjust quality outside the tariff system. Therefore, this issue is not considered in this paper either.

Because of the exceptional cost curves of the rail infrastructure, price setting has always to face trade offs between two or all of the above mentioned objectives. This is highlighted in the next chapter, where the most common pricing principles for rail infrastructure charging are described briefly.

2.3 Pricing Principles

Short Run Marginal Cost Pricing

Marginal costs are the costs which are incurred by an additional train run[2]. They include the above mentioned components. Applying this pricing principle, it is ensured, that every train operator, whose willingness to pay covers or exceeds the marginal costs, can run their train. Each slot allocation will lead to a net benefit. As external costs are substantial (Nash, 2003, 5), they should be included in the infrastructure charge.

SRMC-pricing minimises the exclusion of RU from the network and leads to **allocative efficiency** in a static perspective. A number of examples shows that the implementation is, at least in a rough way, possible, although the definition of the components of marginal costs may differ from country to country. Moreover, it finds acceptance among operators, due to the low costs it generates. These strong favourable arguments face serious caveats.

If marginal costs are considered only in the short perspective, they don't cover the costs of upgrading and new investments in infrastructure, leaving this as a serious problem for the development of the rail industry as a whole. The IM will not have the necessary funds for investments, nor will he have the incentives, as new lines would only increase the deficit in the regime of SRMC-pricing. The problem is enforced by the lack of incentives for the IM to develop new cost-saving technologies, if he is regulated on the basis of marginal costs. He has no means to adjust prices to the demand of the operators, as the prices are set irrespective of this demand. He cannot gain information for investment decisions through price variations. In setting prices according to SRMC, little information about the vehicle characteristics is considered, as the block wise variable costs are fixed in this term. However, the SRMC vary with the vehicle characteristics and this should be considered in the charges, as it provides the operators with information for investment in rolling stock. As the proportion of marginal costs low, **dynamic allocative efficiency** is hardly achieved by marginal cost pricing.

SRMC-pricing results in a deficit because of scale economies and a high proportion of fixed costs. This deficit will be partly covered, if externalities are considered in the pricing system. However, the charging for externalities should not be a financing instrument in order to guarantee allocative efficiency. It will in general not cover the deficit. It is not apparent to claim the charges for externalities to remain with the IM, one reason being that this would antagonize the IMs' incentives to reduce some of the externalities, namely for accidents, congestion and noise. The deficit is in European countries usually covered by the government with general taxes. This raises concerns about the **equivalence** in this system, as the tax payers not necessarily will benefit from the spending of their money for rail infrastructure. The possibility of subsidized train operators benefiting more from the subsidies than tax-payers lose, is very theoretical (Rothengatter, 2003, 125). This holds particularly because of distortions that taxes other than poll-taxes usually entail. If for instance the deficit of the IM is covered by income-taxes, this procedure drives the labour-costs of the very IM away from marginal cost pricing (Baumol & Bradford, 1970, 265). The processes of tax collecting and distribution are to be considered. Complex structures may be cost-intensive and compensate a great deal of the tax income. Apart from the costs of levying taxes, the central investment decision, which is usually linked to the deficit coverage by the government, leads to high information requirements of the investment decisions. If users are only charged at the level of their marginal costs, it is not revealed whether their valuation of the tracks is as such that it justifies the total costs. This makes an appraisal of the project necessary, which faces serious information problems (Laffont & Tirole, 1994, 25). Caveats of tax financing of the deficit

[2] The notion incremental costs is used as well, the difference being the way the costs are measured.

generated by SRMC-pricing leaves the possibilities of cross-subsidization and financing by charges for opportunity costs, which have chances and problems of their own.

Ramsey-Pricing

The aim of Ramsey-pricing is to maximize social welfare under the constraint of deficit coverage. It considers the fact, that the IM supplies different products. They can be defined from the demand-side and the supply-side. Rail infrastructure slots can be differentiated according to different regions, different times and different customers. Ramsey-pricing tries to find mark-ups for these products to cover the deficit that results from SRMC-pricing. The inverse elasticity rule is applied to define these mark-ups. According to this rule, the mark-up (as a percentage) on the marginal costs is reciprocally proportional to the price elasticity of the demand of the operators (while the profit is zero). A rough example in the railway sector is peak-load-pricing. Assuming, that the elasticity of operators' demand is lower at peak-times, the infrastructure tariffs can be raised during these periods[3].

The rule holds for multiproduct-firms with no demand-dependencies between their products. This assumption has to be adjusted for the rail infrastructure provision, as slots for different trains (e.g. high-speed and IC) are partly substitutional. The mark-ups have to be adjusted, but the general tendency remains (Rodi, 1996, 96): Operators with a low demand elasticity pay high mark-ups on the marginal costs. Is the elasticity high, e.g. because of competition in the freight sector, the mark-up might even be zero and these operators would consequently only pay the marginal costs.

A further adjustment of Ramsey-pricing is necessary for the rail industry, as the basic model does not consider substitutional competition from other modes. This is clearly the case in some segments of rail infrastructure, e.g. for freight transport. Under this assumption, the welfare maximization in the transport sector as a whole leads to the necessity to apply a form of Ramsey-pricing for any mode of transport (Braeutigam, 1979, 42). This proposition can hardly be carried out for a variety of reasons. A feasible solution ("partially regulated second best"), which leads to an additional loss of welfare, only considers price regulation of the monopolist. It leads again to the inverse elasticity pricing rule, with the restriction, that mark-ups have to consider the cross price elasticities in respect to the competing products and thus are limited by their prices.

Ramsey-pricing in the textbook form can hardly be implemented. The information requirements impose a restriction on every trial, notably the need of demand elasticities and cross demand elasticities for a variety of market segments. Operators are usually very reluctant to reveal their real willingness to pay, as it is subject to strategic behaviour (Quinet, 2003, 76). Demand curves are not easy to estimate, because of the interactions with other trains. The same holds for cost curves. Therefore, a rule of thump should be applied, following the principle to "charge, what the market can bear". This is a rough but intuitive implementation of Ramsey pricing. It has to consider the marginal costs as minimal price and

Ramsey-prices are a second best solution, as they deviate from welfare maximisation. A set of second best prices is generated for the products of the IM. They achieve **static allocative efficiency**, but only under the constraint of deficit coverage. Prices are higher than marginal costs and the traffic volume is consequently lower than in a marginal cost pricing regime. The absolute degree of welfare depends on the demand and the design of the scheme, but it can be very different from the welfare gained by SRMC-pricing, e.g. if the price elasticity of the demand is high across the market segments.

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[3] The price elasticity of passengers is lower during peak times (van Vuuren, 2002). It can be supposed, that this is due to the high proportion of commuters and low proportion of recreational passengers. It is fair to assume a direct relation between the price elasticity of operators and of their passengers.

Ramsey-pricing allows for a detailed product differentiation by the IM. If the elasticities are known and the differentiation is well done, price differences are to be expected between different regions, times and vehicles. But a differentiated system of prices doesn't provide for incentives for investment and disinvestment. If it is stipulated that the IM charges Ramsey-prices, he has no incentive for investment once his deficit is covered. Above all, Ramsey prices build upon marginal costs and therefore face the same information restraints as SRMC-pricing. Thus, **dynamic allocative efficiency** is not achieved by this pricing principle (Rothengatter, 2003, 126).

As a positive feature, **equivalence** issues favour pure Ramsey-pricing, as the non-users don't have to pay for the infrastructure and thus there are no costs of levying taxes incurred.

Fully-Distributed Cost Pricing

Fully-Distributed Costs (FDC) 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 themselves (Rodi, 1996, 103). The decision, which parameters are to choose, usually doesn't consider blockwise variable costs and is therefore purely arbitrary. This makes the implementation of FDC for railway infrastructure fairly easy and is tempting for decision makers. But in its usual application **dynamic allocative efficiency** is not reached.

As FDC deviates from marginal costs, **static efficiency** is not reached either. FDC-pricing is Pareto-inferior to Ramsey-Pricing, as it doesn't take the demand elasticities into account. This is of course assuming, that these elasticities are known. If the common costs of the rail infrastructure are distributed according to the SRMC or the track-km, slots for feeder-lines and other parts of the secondary network will become very expensive. If the respective operators are priced off the network, all remaining services will have to bear a higher share of the common costs. In this way, particularly the FDC-pricing scheme can cause negative chain reactions. FDC-pricing usually does not differentiate the demand according to different train products, regions or times of the day.

Non-linear Tariffs

Non-linear tariffs - unlike SRMC-prices and Ramsey-prices - 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"). A huge variation of non-linear tariffs exists, including block tariffs. The most simple form is a two-tier tariff, consisting only of one fixed fee (no differentiation between users) and one variable component. The difficulty is to define the fix part in such a way that it doesn't influence the demand of the operators. Therefore, the fixed component must not be higher than the surplus of the marginal operator.

There are significant problems in meeting this condition, if the demands of the operators differ. This is for instance the case in a market with a state owned incumbent and some small competitors. If the deficit covering fee is spread evenly across the operators, competitors are likely to be priced off the rails or the fixed fee can indeed establish a market entry barrier. A possible solution is the adjustment of the fixed fee for each operator or group of operators, leaving the variable unit-price unchanged. This approach might not to meet the competition legislation in many countries because of discrimination. A two-tier system of the main German IM was rejected by the national competition authorities because of price discrimination. Therefore, it might be necessary to vary the variable parts of the price system as well, deviating from marginal costs, but this doesn't necessarily prevent them from being discriminating.

If there are detailed information about the demand curve of each group of operators towards the fixed part and the variable part, customized tariffs can be assigned. Depending on the elasticities, they lie between the basic multi part concept (identical fixed and variable parts for all users) and the Ramsey-prices (no fixed part). As the regulation authority will find it very difficult to generate the necessary information, a system of self-selecting tariffs is a variation, which can be used in practice. It leads to a volume discount. (What information are needed for cost covering?). It can be observed in several end consumer markets in network industries, e.g. in the electricity and the telecommunication sector.

A serious caveat of self-selecting tariffs is its reliance on the operators demand. Users have to know their consumption pattern when choosing a tariff. The theory suggests that the social welfare increases with every new tariff-element (I.e. a variable and a fixed part) introduced, if the new variable part is smaller than all other variable parts, but as least as high as marginal costs (Borrmann/Finsinger, 1999, 225). If the users are uncertain, the danger of selecting a wrong tariff is increased with the number of tariffs on offer and a new tariff might lead to a welfare loss (Train, 1989, 72). As frequently mentioned, demand curves of operators are very difficult to specify and it is doubtful, whether the operators possess this knowledge. The time period, for which the fixed access fee has to be paid, is of great influence on the impact of self-selecting tariffs.

Non-linear tariffs are not designed to reach **static allocative efficiency**. They do so under the constraint of covering (partly) the deficit. However, if demand elasticities between operators are known, the exclusion of RU might be as small as in the regime of SRMC-pricing, thus reaching static allocative efficiency. This is not likely to be the case. From the perspective of cost-recovering, this price regime is Pareto-superior to linear tariffs (SRMC- and Ramsey-pricing) and ensures a higher **equivalence** as those, in the case of a producer - final consumer relationship (Borrmann/Finsinger, 1999, 225).

A great advantage of multi-part tariffs is that they are not based on marginal costs. They can consist of a fixed parts and blockwise fixed parts and as such contain information about the costs (Rothengatter, 2003, 126). On the other hand, they are able consider the demand as well. From the perspective of **dynamic allocative efficiency**, this makes them the appropriate means to set prices on a final consumer market. If the demand is uncertain, self selecting multi-part tariffs can be deployed to gain information on the demand. In this case, the RU reveal information about their willingness to pay for certain products by choosing a tariff. This depends on the degree of variation between the different combinations of multi-part tariffs and the information the IM maintains to construct this tariff.

Setting prices for intermediate goods is more complicated, if the downstream market is not perfectly competitive. This is clearly the case for the railway sector with manifold complementary and substitutional relations between rather few operators.. Welfare-maximizing price setting on the upstream market has to consider welfare effects of the final consumers. The price setting strategy is in this case to decrease the marginal costs of the downstream firms in order to lower downstream prices (Panzar & Sibley, 1989). As the Pareto-superiority does not necessarily hold for the case of imperfectly competitive downstream markets (Borrmann/Finsinger, 1999, 227) and the regulator is very unlikely to generate the information required, it is necessary to regulate both industries. Due to the complexity of relations and tariffs, an effective regulation of the fares and freight tariffs, which would have to adjust prices, seems not to be feasible. Given the possible negative effects of a (simple) non-linear pricing scheme for railway infrastructure, the **dynamic allocative efficiency** is very uncertain.

Conclusion

The analysis of the four standard pricing principles led to the following results:

- SRMC-pricing gains static allocative efficiency, but fails in a dynamic perspective and generates a deficit.
- Ramsey-pricing is a second best solution, it reaches static allocative efficiency only under the constraint of deficit covering. Moreover, it needs a good deal of information. It provides not more (dis)investment incentives than SRMC-pricing.
- The form of FDC-pricing, that is usually deployed, reaches allocative efficiency neither in a static nor in a dynamic perspective. It ensures total cost coverage.
- Multi-part tariffs for intermediate goods can be designed to cover the total costs and are Pareto-superior to Ramsey-Prices and SRMC-prices, regarding allocative efficiency. This holds, if only the market for transport services is considered. The information requirements of the regulator or the consumer (in the case of self selecting tariffs) is high The different parts of the tariffs can be designed to reach dynamic allocative efficiency, again only considering the market for intermediate goods. It is likely to lead to a welfare loss on the final consumer market.
- These results only hold, if capacity is not scarce. If there are bottlenecks, amendments of all of these pricing principles seem possible, e.g. in some form of peak-load-pricing. As mentioned above, there is no algorithm to allocate tracks in the case of scarce capacity.

Variations of the pricing principles or totally different schemes might be possible, which are not considered here. Considering the constraints of pricing principles, it is not too far fetched to assume, that there is no pricing system, which is in general Pareto-superior. The only scheme that can be ruled out is FDC-pricing, given its failure of reaching allocative efficiency in a static or dynamic perspective. This can indeed be adjusted to promise better results than described here (see Rothengatter, 2003, 128).

A pricing system has to be adapted to the specific situation of the infrastructure manager, taking into account a number of parameters. It is very likely to be an adjusted mixture of all these principles. There will be no plain solutions, particularly because of some similarities of the pricing systems that have already been pointed out: SRMC-prices are one extreme of Ramsey-prices and a Ramsey-price for a path can be the result of multi-part tariffs.

Directive 2001/14/EC doesn’t entirely follow this result. It calls for marginal cost prices and allows mark-ups on top of them ("where the market can bear it") as well as higher charges for the funding of investment projects. The directive seems to leave no place for two-part tariffs, but Ramsey-prices would meet the requirements. In order to set these up, an IM has to take into account the demand elasticities and will, if the regulatory setting is right, make sure that the market segment at stake as a whole can bear the tariff. But is unlikely that there will be no exclusion of operators. A certain concern has to be expressed about the directives’ claim, that the charges for "equivalent uses" have to be equal in order to prevent discrimination. For a Ramsey pricing to be successful, the IM has to carry out a detailed product-differentiation. Different market segments are likely to be offered different prices and it may well be that a certain section of the network is offered to operator A (e.g. an intercity passenger train) at a different price than to operator B (e.g. a local passenger train), for the same time. It can be assumed that this claim refers to the use within a market segment, as stated in the same section, and thus represents no obstacle for the implementation of Ramsey prices.

3 Tariffs in the European Union

All of the analyzed IM, with the exemptions of Greece and the Republic of Ireland, have to date implemented tariff systems. They are published and meet the claim for transparency. The focus of this chapter is to analyze the track charges across the European Union in the light of the suggestions of the economic theory and the requirements of directive 2001/14/EC.

3.1 Marginal Cost Prices

SRMC-pricing is applied in Sweden, Finland and the Netherlands. The Swedish and Finish tariff systems are based on detailed cost studies for the wear and tear components, deriving the marginal costs from the total cost function. The charges show, that a form of average-building of these costs is deployed, as there is no variation between different parts of the network and only a distinction between passenger and freight trains in the two Scandinavian countries. The structure of tariff systems[4] of Sweden and Finland shows some differences:

A **circulation fee** is charged in both countries:

- for freight transport in Finland € 0.001223 per gross tkm, in Sweden € 0.0003 per gross tkm, and
- for passenger transport in Finland € 0.001189 per gross tkm, in Sweden € 0.00093 per gross tkm.

To establish the marginal costs, a cost function of the following form was estimated (Thomas, 2002):

$$\mathbf{C_{it} = f(Y_{it}, U_{it}, z_{it}, e_{it})}$$

Where C_i denotes the maintenance (and renewal) cost for track section i at time t, Y_{it} is the length of section iU_{it} denotes the utilisation level (in gross tons) and z_{it} is a vector of technical features of the infrastructure (e.g. the number of switches, age of track, …). The function takes no features of the vehicles that pass over it into account.

The fee for passenger transport and freight transport in Finland is similar, whereas the difference in Sweden shows that the freight vehicles cause much higher costs than passenger vehicles. The cost functions allow no differentiation on the basis of vehicle characteristics, although they may be of a significant influence for the wear and tear. It is well known for instance, that tilting trains cause higher damages than other passenger trains. The passenger circulation fee in Finland is more than four times higher than in Sweden, although in Sweden a mark-up for the **financing of the Öresund-Bridge** is included. The difference is mainly due to the fact that only the Finish tariff system includes renewal costs. Differences for price components between countries can also be generated by different input prices, standards and geographical conditions. Moreover, the definition of the track maintenance may differ between these countries.

The charge for **environmental and accidental costs** in Finland is

- € 0.000182 per gross tkm for electric freight transport
- € 0.000584 per gross tkm for diesel freight transport
- € 0.000098 per gross tkm for passenger transport

[4] All of the tariffs described in this chapter exclude the use of stations and energy, unless indicated.

These costs are separately accounted for in Sweden. The **diesel charge**, accounting for the emission of nitrogen oxides, is € 0.036 per litre for old passenger and freight vehicles and € 0.018 per litre for newer vehicles. In contrast to Finland, the charge is linked closer to the source of the externalities, i.e. the diesel. The **accident charge**, based on average costs, is € 0.118 per train-km for passenger transport and € 0.059 per train-km for freight transport.

In Finland, a **supplementary charge for freight transport**: € 0.19 per tonne of freight is levied. The use of stations is included in the Finish charges. For passenger trains in Sweden, a **charge for information** on platforms and at stations has to be paid. It is € 0.00022 per gross tkm. This is reasonable, as information costs can be allocated to particular trains, although the reference to the gross weight is not straightforward.

There are now proposals in Sweden to add components, which reflect scarcity and congestion costs as well as noise costs and a carbon dioxide tax. The same authors advocate the necessity to include re-investment costs in the marginal wear and tear costs (SIKA, 2002).

Fees for the use of the tracks in the **NETHERLANDS** have been introduced in 2000. The system is simply structured. Charges are levied according to the train-kilometres

The charges differ for

- (official and private) passenger transport (basic charge),
- freight transport (reduced charge) and
- Deadhead runs (no charge).

The tariff system is designed to cover the marginal costs, consisting in (Prognos, 200, 56 and IMPROVERAIL, 2002, 177f)

- daily maintenance,
- major maintenance,
- traffic management, and
- (use of stations).

If rivalry for a path cannot be resolved by its price and the priorities deployed in the timetabling process, an **auctioning process** will decide over the final allocation.

A **transition phase** is foreseen until the marginal costs are totally covered by infrastructure charges. It will last until 2005 for passenger transport and until 2007 for freight transport. The increase in charges is stipulated as follows:

Table 1: Dutch Charging Parameters

€ per train-km	**2003**	**2004**	**2005**	**2006**	**2007**
Passenger Transport	0.5594	0.7459	0.9324	0.9324	0.9324
Freight Transport	0.3357	0.5221	0.7459	0.8391	0.9324

Source: Prognos, 2000, 56

It is not clear to the author whether there has been a cost study in the Netherlands. It can be put into question, as the charges are independent of the weight, and identical for passenger and freight transport.

3.2 Linear Tariffs

In Austria, Belgium, Denmark, Portugal, Switzerland and Germany, the prices are not only cost-based. This leads to a partly closure of the gap between the income of the IM and its costs, but in all of these countries, public spending is required to finance the infrastructure.

For the tariff system of **AUSTRIAN** Österreichische Bundesbahnen (ÖBB), a marginal cost study was carried out, which led to a **wear and tear** component (for maintenance only) of € 0.001 per gross tkm. Further components of the tariff system are:

- a **circulation fee** per train-km, which varies for the six different line categories between € 0.60 and € 2.50,
- a **discount for single load freight transport** of € 0.30 per train-km, and
- a **scarcity component** of € 0.50 per train-km for two relations going into Vienna, each of which applying for 05:00h-09:00h and 15:00h – 19:00h

The **BELGIAN** Société Nationale de Chemins de Fer Belges (SNCB) uses a linear charging system with two base components – one for the use of lines, the other for the use of stations. The line charge per kilometre is determined for each section by multiplying a unit price of € 0.2672, which applies for all sections, with two coefficients. Coefficient **C1** reflects the **operational segregation** of the network. It reflects the demand for the particular section and the revenue yielded on these tracks. There are four different categories of lines, ranging from 1.0 to 2.0.

The **technical equipment** (maximum operating speed, …) of a requested line is also considered (Coefficient **C2**) in the tariff, at the same time as investment and maintenance costs. There are six technical categories of track identified, ranging from simple industrial lines (C2 = 0.75) to main lines which allow a speed of more than 220 km/h (C2 = 5.0).

This base component for the use of lines is then multiplied with various coefficients, according to train load, SNCB-train type, or congestion. The use of SNCB-train types as categories causes problem as it is not in any case compatible with all rolling stock available. The coefficient for the **gross train load** (**C**) increases discretely with its weight, starting at 1.2 for a gross weight of 0 – 400 t, then increasing in steps of 0.4 for each 400 t. Different **train types** are also treated differently in the tariff and assigned different coefficients (**Pt**), ranging from empty runs (Pt = 1.0) to high speed trains (Pt = 2.0). This coefficient considers also the **priority** given to a train, notably in case of disruption. The **congestion** of a requested line also affects the price level, as there is a time-band- and weekday-based coefficient (**H**) defined for each section reflecting the specific demand. This coefficient equals 1 for a normal density of traffic, 1.5 at semi-peak hours and 2.0 at peak-hours. SNCB also plans to implement a coefficient **T** (currently set to 1), which considers the **duration of the train journey** in relation to the standard speed defined for the specific line. This is in line with the method suggested by Nash et al to charge for the use of capacity (Nash et al, 2003). It would partly reflect the opportunity costs of the IM which cause TOCs deviating from the ideal of speed harmonised transport. Recently a coefficient **(Ce)** added in order to reflect the impact **of the train run on the environment**. It is currently set to 1.

The final charge P per train-km on a particular section is obtained as follows:

$$\mathbf{P = € \ 0.2672 \times C1 \times C2 \times C \times Pt \times H \times T \times Ce}$$

The usual charge lies within the range of € 1.2 to 2.5 per train–km (Kirchner, 2002, 38).

In **DENMARK**, the following **tariff system** is deployed (Banestyrelsen, 2003):

- A **distance-related fee**[5] is charged:
  - € 1.53 per train-km for freight trains and € 3.75 per train-km for passenger trains on main lines (Öresund-coast – Copenhagen H/Padborg border)
  - € 0.29 per train-km for freight-trains and 0.58 € for passenger trains on other lines.
- **Bridge fees** have to be paid for
  - The Danish stretch of the Öresund: € 221 per passenger train, 338 € per freight train
  - The Great Belt: 1118 € per passenger train, € 120 per freight wagon (max. € 1033)
- Only freight trains are charged an annual **access fee** which is at € 0.29[6] per annum and km for the line, the freight operator has been allowed to use.

An environmental motivated **subsidy** of € 0.003 per ton-km is granted for internal freight transport (max. 50% of total sales price). The bridge fees show, that the tariff is not SRMC-orientated. They facilitate the financing of the new infrastructure in a way which ensures a higher equivalence compared to Denmark, where any passenger train has to pay a mark-up for the financing of the Oresund-bridge.

The operation costs in **PORTUGAL** are stipulated to be covered by non discriminatory access fees. The government finances renewals, upgrading and new building (Briginshaw, 2001). However, the total costs are estimated annually as a function of the track kilometres under the assumptions of the highest operational and technological efficiency. This serves as an incentive for Rede Ferroviára Nacional EP (REFER) to improve its performance. The virtual costs are divided yearly among the operators taking into account the following parameters (IMPROVERAIL, 2002, 200): the train kilometres, the composition of the rolling stock, the speed, and the axle load.

This is a tariff regime which is entirely based on FDC. In the current form, it prevents the calculation of costs for new entrants and incumbents and has to be considered as problematic. So could the infrastructure tariff for 2003 only be established in January of the same year. This has not caused major problems so far as the government is reluctant to issue new licences for the internal market. In practice, the tariff setting is not consistent with the legislation. The charging system of the only competitor, Fertagus, are defined in its concession. In addition to the criteria mentioned above, they depend on the passenger kilometres (Briginshaw, 2001), which are to be estimated by the operator itself.

In **SWITZERLAND**, the infrastructure tariff for the tracks of Schweizerische Bundesbahnen AG (SBB) and Bern-Loetschberg-Simplonbahn AG (BLS) consists of two parts:

- The **minimum charge:**
  - Freight trains (subsidized) pay for maintenance € 0.0065 per gross tkm and € 0.26 per train-km for the operation (all prices exclude VAT[7]).
  - Passenger trains pay € 0.016 per gross tkm for maintenance and € 0.26 per train-km for the operation.

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[5] All prices include VAT of 25 %.

[6] 1 DKK = 0,13 € (24/07/03, www.exchangrate.com)

[7] International Rail Transport does not pay VAT.

- The **contribution margin:**
    - o Franchised passenger transport pays a fixed percentage of its revenues as a contribution margin. This percentage is defined by the regulation body for each franchise.
    - o Non-franchised passenger transport pays € 0.0018 per km.
    - o Freight transport pays € 0.003 per net ton-kilometre on the SBB infrastructure and 0.0023 per gross-tkm on the BLS infrastructure. On this network, slow freight carriers (v_{max} < 60 km/h) pay an extra fee. Both the contribution margin on the BLS- and on the SBB-network are currently paid by the federal government.

The **average prices** per train-km are € 1 for regional passenger transport, € 1.7 for long-distance passenger transport and € 1.2 for freight transport (SYNETRA, 2003, forthcoming). Slow trains on the BLS-network pay a capacity charge which seems to be based on a standard path, although there is no extra fee for fast trains. The minimum charge was elaborated as marginal costs of using an average standard modern infrastructure (IMPROVERAIL, 2002, 226).

The **infrastructure charging** system of **GERMAN** Deutsche Bahn Netz AG (DB Netz) is a linear tariff. When it entered into force in 2001, it was the third charging system DB Netz had set up within seven years, changing the structure significantly with every new trial. It is currently rather differentiated and sets the price of a slot in three steps (see figure 1) (DB Netz AG, 2003):

- setting a base price dependant on line categories,
- multiplying a product factor and
- multiplying and/or adding additional factors.

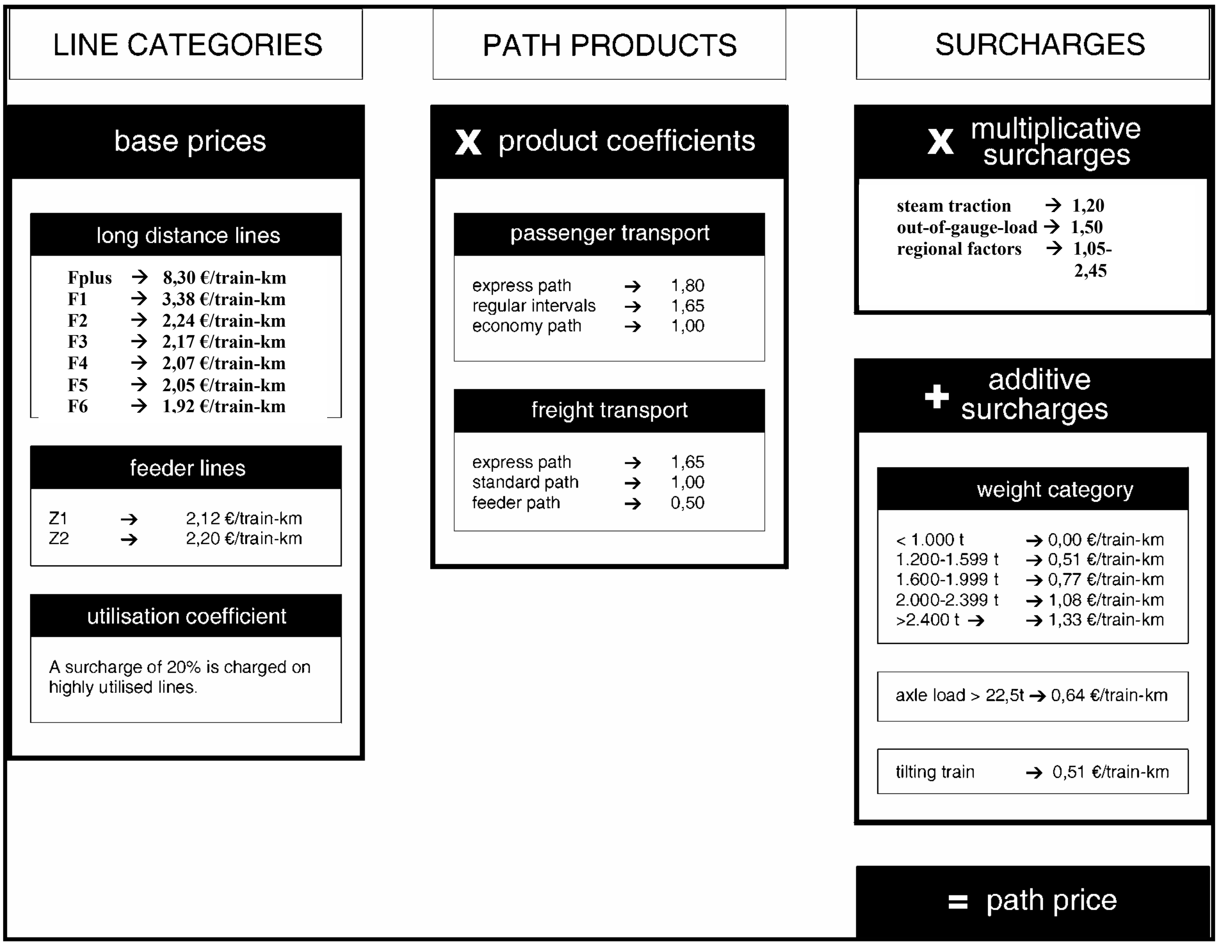

Figure 1: The German Infrastructure Charging System

Source: own chart on the Basis of DB Netz

Line Categories and Product Categories

The **line categories** reflect the technical quality of the line as well as its functional role in the network. The categories stretch from lines, which allow a speed above 280 km/h (Fplus), to basic lines, which allow only a maximum speed of 50 km/h. The most important indicator for the technical quality is the maximum velocity. A surcharge of 20 % is levied on lines with a high demand in order to equalize the traffic.

The **product categories** reflect the priority of a path for route planning and delay management, and the mean velocity of the path:

- **Express paths** are fast and direct paths between metropolitan areas. These paths are of highest priority in timetable planning and available for both freight and passenger transport.
- **Standard paths** are available for all freight trains and are used for long-distance transport. Because of the low priority, there are few choices in timetable planning and therefore little flexibility for the train operator.
- A **feeder path** is a freight path, which is connected to a standard or express path. It is provided only for the distribution or collecting of wagons.
- The **regular-interval path** is available only for (regional and long-distance) passenger transport.

- **Economy tariffs** are aimed at non regular transport. It is the intention of DB Netz to provide an access facility for RUs, which cannot afford the other tariffs.

Surcharges

There are additive and multiplicative surcharges:

- **Out-of-gauge load**: Trains exceeding the regular gauge entail higher planning expenses. Therefore a coefficient of 1.5 is multiplied on the line charge.
- **Gross train weight** over 1,200 t: This wear and tear indicator increases in four categories up to 2,400 gtkm:
    - 1,200 – 1,599 gtkm + 0.51 € / train-km,
    - 1,600 – 1,999 gtkm + 0.77 € / train-km,
    - 2,000 – 2,399 gtkm + 1.08 € / train-km and
    - >= 2,400 gtkm + 1.33 € / train-km.
- **Regional factors** vary between 1.05 and 2.45 and apply only for regional passenger transport.
- Lines which can bear **axle-loads** over of 22.5 t need a superstructure above normal German standards. Trains exceeding this axle-load cause additional costs and are charged an extra 0.64 € / train-km.
- For **tilting trains**, an extra fee of 0.51 €/train-km is levied.

If the price system and priorities in timetabling do not solve the rivalry for a certain paths, the infrastructure manager tries to mediate between the RUs. The ultimate solution is a bidding process.

The tariff system of DB Netz is characterized by **supply-side price differentiation** and a demand side price differentiation. The supply side differentiation relates the price, which has to be paid per track-km, to the quality of the assets. The main indicator is the maximum speed. There are nine different categories for regional and long-distance lines, compared to six categories in Belgium and Austria and only two in Denmark. In Germany, the tariff generally increases with the maximum speed. This rule doesn't apply for the feeder lines (Z1 and Z2), the argumentation of DB Netz being, that the traffic on these lines is too sparse to further reduce the price. This argument indicates a fully distributed cost approach in the tariff setting, where (a part) of the fixed costs is distributed among the user of a line. The price difference between the categories F3 and F4 underlines this. Both allow for the same speed, but F3 contains lines for mixed traffic, which usually require higher infrastructure investments. The price spread between the lines is rather low (€1.92 - €3.38 per train-km), given the fact, that only one line is categorized Fplus (€ 8.30 per train-km). A major redistribution of traffic is not likely to be caused by this spread. The surcharge for highly utilised lines leads to a further variation of the base price. It can be interpreted as a Ramsey-element of regional price differentiation. The capacity-surcharge in Austria is more differentiated, as higher prices apply during the two daily peak-periods on busy lines. Even more sophisticated is the capacity surcharge in Belgium, with the additional possibility to vary from day to day.

The **demand-side price differentiation** in Germany is particularly interesting for non-*takt* passenger transports and freight transports. Operators can choose between different products, according for their preferences for priorities in the planning process and during operation. It must be noted, that the overall priorities of DB Netz don't depend on the path product. Therefore, the advantages of a more expensive path-product are not clear and it can be considered as a means to differentiate consumers' willingness to pay. As such, it is a Ramsey element.

Several surcharges apply. A charge for the weight is levied only from 1200 t, which indicates that there is no marginal cost related element for trains under this limit. The regional factors were introduced in 2003. The logic of their differentiation is, according to DB Netz, to have higher fares in the parts of the network, which struggle with a low cost coverage. This indicates an application of fully distributed costs. It might be argued that DB Netz is responsible for a part of the underutilisation, because of neglected maintenance (Link, 2003). It is frequently argued, that the tariffs for the regional sections of the German network cross-subsidize the long-distance lines for passenger transport. Applying a normative definition of internal subsidization, the price for the regional tracks must exceed the marginal production costs. This is certainly the case, as the highest MC in Europe (in Finland and Austria) are at about € 0.001 per gtkm, the cheapest train run on a long-distance line for passengers costs € 1.92 per train-km. It is more appropriate to deploy a different definition of internal subsidization, as the IM is not MC-regulated. According to the definition on stand-alone-costs, DB Netz is not internally subsidized, if the stand-alone costs of all subsets of products are higher or equal than the revenue generated on the part of the net at stake (Laffont & Tirole, 1994, 31). It would be a prove of cross-subsidization to show, that therevenue on a particular section is higher than the stand-alone costs This can't be proven, as the necessary cost and revenue data is not available. The reason for DB Netz' strategy in the region is to find in the funding of regional passenger transport. The German regions are responsible for the ordering of the transports and pay directly or indirectly for the use of the infrastructure. The funds to buy these services stem from the federal government and are earmarked. Therefore, the price elasticity of the regions is very low. Thus, the regional factors can be seen as further application of Ramsey-pricing.

As a result, a path-km for regional passenger trains costs between around two and over ten € per train-km (depending on the region) and for freight trains (with less than 1200 t and less than 160 km/h) between approx. one and €4.5 per train-km. The maximum price for a long-distance passenger train path – apart from the relation Koeln-Frankfurt is €7.3. Thus, paths for regional passenger transport can be more expensive than for long-distance transport. This might be incurred of FDC- or Ramsey-pricing. Compared to other countries, the application of a weight-dependent parameter only from 1200 t leads to high prices for wagon load transport (>= € 1.06). This is likely to drive this carriers off the rails, as the maximum HGV-toll on roads will be at €0.17 per km.

3.3 Non-Linear Tariffs

The following countries have chosen tariffs, where the price per unit changes with the amount of the ordered: Italy, Spain, Luxembourg, United Kingdom and France. The conclusions so far cast shadows on these approaches in two ways: two-part tariff systems are likely to have negative welfare effects on the end consumer markets and they seem not to accomplish directive 2001/14/EC, although the latter has to be subject to a juridical analysis.

The charge in **ITALY** is composed of **three elements** (IMPROVERAIL, 2002, 168f and RFI, 2002a):

- **access to sections** of the main lines: dependent of the section, ranges from € 0 (sections with scarce traffic) to € 64.56 (e.g. for Firenze – Roma),
- **usage costs**, which depend on train speed, weight, traffic density and time band, and
- **access to nodes**, the base price being € 1 per minute of stay.

This charge, which covers between 10 % and 50 % of the total infrastructure costs (Marucci, 2002, 28), does not include the usage of the stations (being € 51.65 for eight large passenger stations) and the traction current.

Two **discounts** are granted (RFI, 2002a):

- The discount for the use of track applies only for trains which run 120 km or less. It varies according to three time bands, the least discount being granted between 06:00h – 09:00h. Moreover, it varies according to the technical equipment of the line. The network has been differentiated into seven segments. The highest discount applies – roughly spoken – to the lowest standard.
- The discount for the volume of traffic is:
  - for freight transport € 0.612 per train-km,
  - for long-distance passenger transport € 0.312 per train-km, and
  - for short-distance passenger transport € 0.032 per train-km.

The tariff to be paid in **SPAIN** contains, among others, the following parameters and the respective indicators:

- an invariable access fee for assignment of capacity and supervision of the operation,
- a reservation fee, depending on the train-kilometres ordered,
- a train-related fee, depending on the gross weight, the train-kilometres and technical features and
- a fee depending on the commercial value of the trains capacity (seat-km, ton-km, TEU).

The most striking feature is the last element, which aims at the willingness to pay of the operators and is depending on the capacity. This component of the tariff system is in line with economic theory, as the willingness to pay is linked to the capacity of the rolling stock in use.

The tariff system in **LUXEMBOURG** is composed of three elements (CFL, 2003, 35ff):

- An **access charges** per path and timetable period, usually € 155.30 (standard path)
- An **usage component C = a*b*c*d**, depending on the base price of € 1.479 (**a**), the length of path (number of km) (**b**) and
  - a factor for the gross weight (**c**), ranging from 0.6712 to 1.841 and
  - a factor for the train type (**d**), ranging from 0.6126 (combined freight) to 1.0507 (passenger railcar).
- A **congestion element** for time bands on sections of the network which have been declared congested. The element **D=e*f*g** depends on the base price of € 15.28 (**e**), the length of the congested section in km (**f**) and
  - A rigidity-factor (**g**), which reflects the rigidity of the particular path in the timetable, which the operator and the IM have agreed upon. This factor ranges from 100 % (< 3 min) to 2.5 % (> 60 min).

The tariffs in the **UNITED KINGDOM** are negotiated between Network Rail, the new IM, and the Office of the Rail Regulator (ORR) before bids are sought. The basic idea of the first tariff system was to charge operators for the avoidable costs they cause and let them pay for the common costs according to their ability to pay (Nash et al, 2003, 2). The avoidable costs, which equal the incremental costs in the case of one train run, were further split up into (Dodgson, 1994, 207):

- Usage-related costs:
    - Track usage,
    - Traction current, and
    - Peak charges.
- Directly attributed fixed costs: the long-run avoidable costs that arise from a particular operator using the tracks.

Three types of **common costs** are distinguished (Dodgson, 1994, 207):

- costs for the use of specific sections of the network: applies, if the section is used by more than one operator,
- costs that can only be attributed to a geographic areas, e.g. costs of power boxes, and
- network costs: the remainder of the common costs.

This resulted in the following **average structure** of the passenger transport charging system for the first review period (1997 - 2001) (Nash et al, 2003, 2):

- 8 % variable charges, most of it for electricity and
- 92 % fixed charges:
    - 37 % of the total charge to cover the long term incremental cost of capacity for the designated operator,
    - 43 % of the total charge as a contribution margin to cover the common costs:
        - about half of this (arising at below the zonal level) determined on the basis of planned train-km and
        - the other half (arising at national level) determined on the basis of budgeted revenue.
    - 12 % of the total charge to cover the costs of stations and depots, distributed between the respective operators, on the basis of output measures.

The variable charges are derived by means of a top-down approach, which estimates the variable costs, i.e. the maintenance and renewal costs, of the different asset elements (track, structures, signals, and electrification). These are in the next step allocated across all vehicles using the respective assets, taking into account the damages that different vehicles cause (Thomas, 2002). Unlike in Sweden, Finland and Austria, the marginal (or incremental) costs are generated by using engineering relationships.

The average charge per train-km was about € 8 (£ 5) in 2001 (Preston, 2002, 2). The charge can usually be changed at the end of a control period. If changes catch a franchisee during their contract period, the SRA has to account for the entailed surcharges (in the case of increased charges) or receives the difference from the operator (in the case of charge reduction).

A **performance regime** was introduced alongside these charges. The infrastructure manager has to compensate the operators for delays, which are not caused by the latter. On the other hand, the infrastructure manager gets rewards for a performance over the historical benchmark.

This system was criticised in some ways:

- the variable part was to low due to an underestimation of the wear and tear costs,
- no incentive of efficient use of peak capacity,
- no incentive for the infrastructure manager to extend capacity,
- no incentives to replace low value services with higher ones, and
- no congestion and scarcity costs (opportunity costs) considered.

These Problems were partly tackled at the end of the first review period, when **changes** were introduced:

- the variable part of the track charges was increased, and
- congestion costs were specified by network section and time and 50 % of the congestion costs are reflected in the tariff system.

Furthermore, an incentive payment to the SRA for traffic increase was introduced. The current procedures of price determination for new tracks (freight and passenger open access transport) is a negotiation process which leads to access prices between the avoidable costs and the value of the path to the operator. The charges for freight carriers are subsidized by the SRA and now only consist of a variable part, which is published

The tariff system for the utilisation of infrastructure in **FRANCE** consists of three parts which are levied per section (IMPROVERAIL, 2002, 137):

- A fixed access charge (see below),
- A reservation fee for circulation, which is independent from the use of track, and
- A circulation fee, dependent on the actual use in terms of train-km, gross weight and transport type.

The total amount of infrastructure charges is stipulated in advance for each year. The same applies for the weightings of the three components (IMPROVERAIL, 2002, 136). For e.g., the share of the access charge was reduced for 2001 from 11 % to 4 % (Quinet, 2002).

The fees differ according to the **section of the network**. There are four categories of lines, which are subdivided into twelve subcategories, which take into account the demand on the respective lines. The basic categories are (RFF, 2003).

- Suburban lines (A,B),
- Major intercity lines (C, D),
- Other lines (E), and
- High-speed lines (N).

A further differentiation of the circulation fee applies depending **on the time of the train** run (RFF, 2003):

- Normal times: 04:30h to 06:30h, 09:00h to 17:00h, 20:00h to 00:30h.
- Peak times: 06:30h to 09:00h, 17:00h to 20:00h and
- Weak times: 00:30 to 04:30h.

The charges for some line categories are composed as follows. Table 1 shows that there is a large difference between access fees and reservation fees of the lines

Table 2: Tariff System or RFF (fraction)

Price in €		Line Categories		
		B: Suburban lines with average traffic	**C: Major intercity lines with average traffic**	**N1: High speed lines with high traffic**
Access fee[8] (per track-km used and month)		373.124	3.110	4475.912
Reservation fee (per path-km)	Normal time	1.244	0.082	9.780
	Peak time	2.488	0.082	11.544
	Weak time	0.622	0.000	4.813
Usage fee (passengers) (per train-km)	0.806			
Usage fee (freight) (per train-km)	0.235			

Source: RFF, 2003

With the beginning of 2003, a **variation of the access fee** was introduced for some line categories. On the network segments A, B and N the access fee depends on the number of paths per month, which are reserved in the respective category. The modulation factor M reaches from 0.03 (for ten paths per months or less) to 1.5 (for more than 1000 path per month). The fixed access fee increases per unit with the number of train-runs on a specific section and herewith discourages an increase of traffic volume. The French tariff system represents a multi-part tariff, with one variable part for the passenger operators and another one for the freight operators. With the variation of the fixed access fee according to the volume of demand, it is implicitly assumed, that the willingness to pay decreases with this demand.

A further **decrease of the** access fee is granted, if the operator signs a contract for more than five years. The infrastructure managers preference for medium-term security of its planning and investment processes are reflected with this feature of the tariff system. Freight trains, which run at least 300 km or whose average speed (without stops) is less than 70 km/h, only pay 60 % of the access fee. This leads to a price decrease of slower and short-haul freight transport (RFF, 2003), reflecting the competition from the road, particular in local and regional freight transport.

The rail infrastructure is classified into the subcategories in two steps. The first step seems to reflect the capital costs of the assets, the second step reflects the demand for slots within each class. There are different fixed access and reservation fees for each of the twelve resulting sub-classes. The reservation fee itself is subject to peak load pricing, which is implemented by a fixed component. This is justified, when the reservation of the paths itself leads to exclusion of other operators. The existence of a reservation fee in the French tariff system is not unique, as it finds its equivalence in a cancellation fee in any other tariff system. These cancellation fees don't show the same degree of variation. The usage prices are the same for each section and don't depend of the trains' weight, as a SRMC-based price would suggest.

The access fees in Italy has to be paid per section (and not for the class of track) as well. In contrast to the French system, the price is set up according to the relation. It is not neutral to

[8] All fees exclude taxes.

the operators' choice of route. This makes sense in the light of the Ramsey-pricing, as the willingness to pay of the operators depends heavily on the specific relation. In Spain, the access fee entitles the operator for the use of the whole network (and not only one section) and is more likely to spread the traffic on different lines. On the other hand, it bears the danger of excluding operators, if the fixed access fee to the network is high and works as an market entry barrier.

4 Observations and Recommendations

General Observations

The sheer establishing and publishing of a tariff system in most of the scrutinized countries has to be emphasised as a positive development. Often, it is already accompanied by a network statement, as required by directive 2001/14/EC. It contains the conditions of infrastructure access. All infrastructure charging systems are – in varying degrees - linked to the physical utilization of the tracks. The demand is generally not sufficiently taken into account. Height of prices and structure of services differs significantly. This show the examples in Figures 1 and 2.

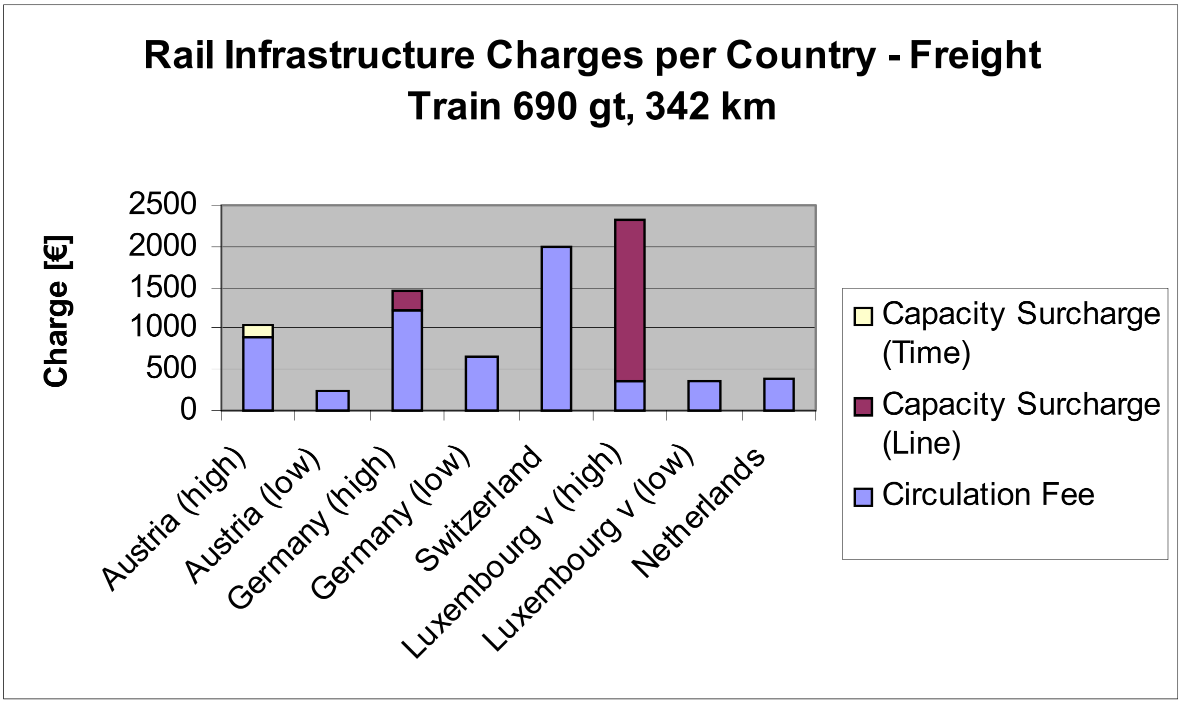

Figure 2: Exemplary Freight Train Run in Five Countries, Varying Line Categories and Utilization factors
Source: Own Calculations

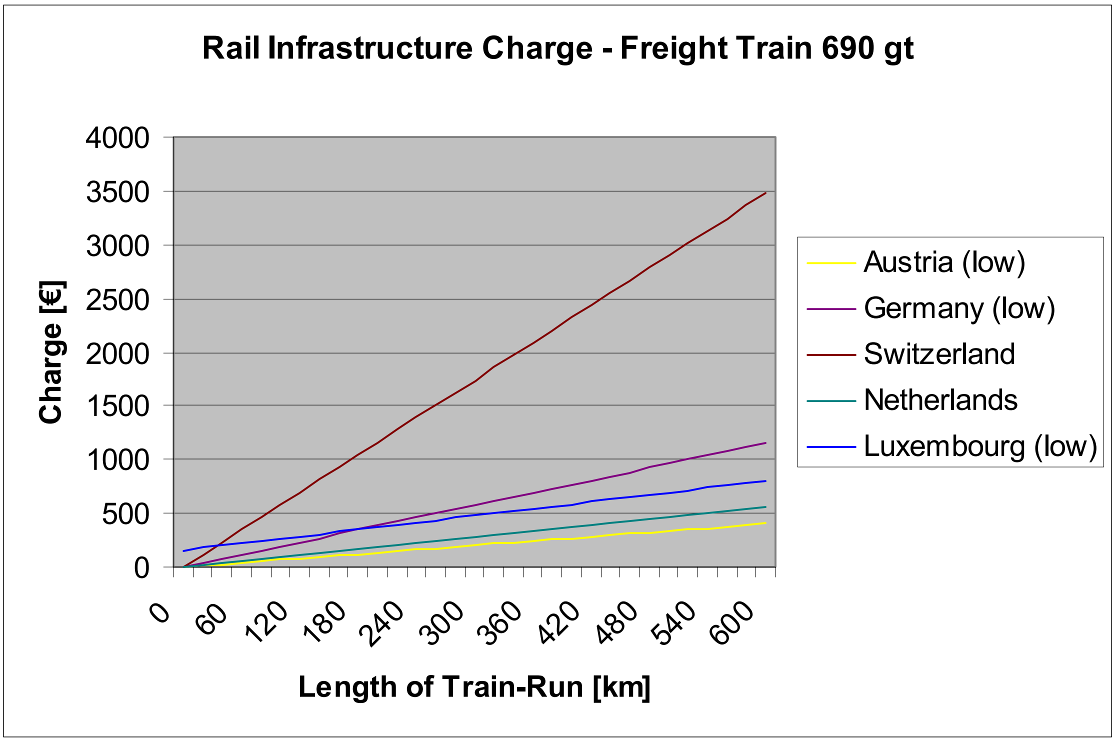

Figure 3: Exemplary Freight Train Run in Five Countries (Cheapest Possibilities)[9]
Source: Own Calculations

Nine of the 16 IM have chosen a linear tariff, two have no tariff system at all. Three of them are mainly based on **SRMC**. Within each of these countries, the respective charges are equal for all types of assets, although some studies found different results for different types of line (Thomas, 2002). Noise is not considered and should be a subject of further studies – as proposed in Sweden. Still unsolved is the crucial problem of capacity costs, although there are several attempts, which mostly charge higher prices for busy sections and/or peak times. An additional possibility is on trial in the UK, where the congestion charge is based on historical data, and in Belgium and Switzerland (BLS network), where the time difference to a defined standard path is charged.

Other charging systems show no direct sign of SRMC-pricing at all, as gross-tons are not considered, notably Denmark, France, Germany (only from 1200t) and the Netherlands, although it is claimed that the tariff system of the latter is designed to cover the SRMC in 2006. Single wagon freight transport is likely to be priced off the rails, if its low weight is not reflected in the tariff. **Price reductions for freight transport** are granted in most of the countries (exemptions are Sweden, Netherlands, Belgium, Luxembourg, Portugal, Spain). The only country to add a surcharge for freight transport is Finland. Some of the reductions apply only for single wagon load transport (Austria, Germany), the others for any freight transport. The form of reduction depends on the motivation behind it. A compensation for positive external effects on the environment (diverting freight transport from the road) can be assumed in Switzerland and the UK, where the government compensates the IM for the reductions. In other countries, the reduction is likely to reflect the competition from road transport and thus the price elasticities of the demand.

[9] Note: The tariff for the train run in Luxembourg contains an access fee of € 155.30 per timetable period. It is assumed implicitly, that this is the only train run of this operator during this period.

Recommendations

A rail infrastructure charging system should be linear and accompanied by an incentive regime. This result is only gained by taking the EC legislation into account. A multi-part tariff system is not ruled out by economic theory. A linear charging system has to consider usage costs and demand. Marginal cost should constitute the minimum price and should be amended by prices for externalities, that can be determined with a reasonable effort. Short run marginal cost prices should account not only for wear and tear, but also for renewal costs. The Finish example proves that this is possible. If a line can only cover its SRMC in the long term, this is a sign for disinvestment, unless network effects suggest that it accounts for coverage of the fixed costs by carrying traffic to other lines. If the deficit of the IM is dissatisfying, it has to be a serious option to increase these prices or to abandon lines, as most of the European networks suffer from sparse traffic. Every IM should be aware of the SRMC of its lines, as they are crucial for pricing and (dis)investment decisions. It is not recommendable to apply average MC in too large a scale, as they mislead operators in their decisions to invest in rolling stock. Therefore, SRMC should be differentiated, taking into account vehicle characteristics.

SRMC are likely to apply for non scheduled freight transport on underutilized lines, as there is significant competition in the freight transport markets and no scarcity of slots on these sections. **Demand-based mark-ups** have to be implemented wherever it is possible to achieve a coverage of the fixed costs. A tariff system that is defined in such a way would be in line with directive 2001/14/EC. The findings from the analysis of the different European tariff systems give valuable hints for the design of such a system.

Demand elasticities are considered in different elements of the analysed tariff systems. Peak-load pricing is a good example of time-based differentiation, although most of the charging systems lack a **weekday- or season-based variation** like it is applied in Belgium. This reflects the fact that demand elasticities are likely to be higher on a Friday evening than on a Wednesday evening. Ramsey pricing suggests a further **modulation of the distance-related pricing**, too. In all countries, the charges increase with the distance. This may well reflect marginal costs of the train run. Apart from Italy, the infrastructure tariff doesn't take the specific relation of the service into account, although the demand elasticities certainly vary according to origin and destination. Furthermore, a pricing per relation could account for competition from other modes. If competition from aviation becomes relevant with the distance, lower mark-ups on marginal costs for the specific relation would be the answer of Ramsey-prices. The distance-related increase of infrastructure prices is very likely to be counterproductive. This holds for relations with competition from aviation. The possibility to take the plane increases the price elasticity of demand. For example is the elasticity of passenger for the relation Paris-Marseille -1.0 (travel-time 3 h, 2001) and for the relation Paris-Nice -1,5 to -2 (travel time 6.5 h, 1999) (Quinet, 2002). There is also a case for the above mentioned mark-ups during daily peak-times. Studies of travel behaviour in the Netherlands show an elasticity during morning peak-hours of -0.68 and during off-peak time a value of -1.37[10] (van Vuuren, 2002, 104).

A good measure to target the height of the operators' willingness to pay is to **charge according to the capacity of the train** (in passenger seats or maximum payload of the respective train). This element of the Spanish tariff system is a good complement to the **charging of particular train classes**, like in Luxembourg. A double deck train type generates

[10] These values have not been generated from the same data sets. Although they cannot be compared directly, the tendency is obvious.

more revenue to the train operator than a one deck train and therefore raises their willingness to pay.

5 Conclusion

This paper advocates a form of Ramsey-pricing although there are information problems and a welfare loss from a static perspective, compared to a plain marginal cost scheme. The analysis of four standard pricing systems shows, that no pricing system is in any case Pareto-superior. Multi-part tariffs are ruled out, because they seem not to be accepted by directive 2001/14/EC. This leads to a limitation of freedom the infrastructure provider would have had otherwise. None of the tariff systems is able to solve capacity problems, this is done by priority rules for slot allocation during the timetabling and during operations. As long as infrastructure prices are not able to account for scarcity, pricing is of limited relevance for the capacity allocation and investment decisions. This is an important field for further research.

Not only economic objectives are pursued with an infrastructure tariff system. An eclectic and varying mix of social, regional, ecological, public finance and other aims is usually burdened on the railways. The stakes of governments of different geographical level in the rail sector and their often unspecified and changing objectives make the railways a business that is hard to manage, particularly with the public interest it usually perceives. It is therefore most important to reduce the day-to-day influence from governments. For the IM to become sufficiently independent means to establish clear and transparent relationships between the infrastructure provider and the government. They should be foreseeable in the long run. An important step forward would be the definition of a cost coverage ratio to be achieved by the IM. Good examples of commercial relationships between public or private RU and governments, including public service obligations, suggest that this approach should be expanded to the infrastructure. Once these relationships and the regulatory framework are clear, a tariff system that matches these requirements, can be developed to make the IM deliver the optimal services in the most efficient way. To enhance this development, it is crucial to leave a degree of freedom about the structure and the height of the tariff system to the IM, alongside with the possibility to gain some profit. This incentive will lead to a maximum effort to meet the demands of its customers.

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