DIFFERENT

User Reaction and Efficient Differentiation of Charges and Tolls

DELIVERABLE D7.2

USER REACTION ON DIFFERENTIATED CHARGES IN THE RAIL SECTOR

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EXECUTIVE SUMMARY

Charging in the rail sector has, over recent years, made a number of moves towards greater efficiency and this has tended to lead to a greater degree of differentiation in the charges. Whilst concerns regarding user reactions have featured in the debate about infrastructure charging systems, they have not been the subject of detailed research. Instead, research has tended to focus on the design of infrastructure charging regimes which, in principle, promote efficient use of the infrastructure, efficient investment or which enable a particular degree of cost recovery.

This work package aimed to develop a better understanding of the ways, in principle and in actuality, in which users react to differentiated charges in the rail sector and propose a methodology for determining appropriate levels of differentiation. Our research focuses mainly on rail infrastructure charges. An interim report, D7.1, preceded this deliverable. It comprised a review of the policy and academic literature, a series of case-study investigations, including a round of 25 interviews with industry stakeholders, and a review of research methodologies that might be employed.

Whilst reactions may be difficult to analyse (due, in particular, to data availability) and, in certain situations, relatively limited in scale, our interviews did uncover which sorts of parameters have been affected. The details of these findings were given in D7.1.

In light of the data availability problems encountered, it was agreed that the final phase of the work package pursue the following streams of work:

- Case study work focused on the Freight market in Britain;
- Case study work focused on the freight market in France;
- Case study work focused on rail freight through Eurotunnel;
- Modelling work based on the freight market in Britain;
- Simulation modelling of the downstream market using Quinet and Meunier's techniques;
- Case study work on the role of Regional factors in Germany;
- Case study work to analyse impacts in relation to passenger fares in Germany; and
- A review of passenger fares elasticities and attitudes to different fares structures.

In Britain, rail freight growth commenced immediately after privatisation of the industry, and we do not observe a major change in the trend around the time of the reductions in infrastructure charges introduced in 2001. Nevertheless, the structure of charges appear to be incentivising operators to reduce impact of rail freight on the network, e.g. by operating less-damaging rolling stock and by requiring fewer slots to operate a particular service. Further changes are soon to be implemented, involving greater differentiation and increased charging levels for freight-only lines. It will be interesting to monitor any observable impacts of these forthcoming changes.

In France, freight infrastructure charges went up and freight traffic went on a downward trend from the end of the 1990's. However, the linkage between charges and traffic remains unclear and probably low. First, a notable effect occurred when reservation fees were implemented and led to the suppression of "facultative" paths that were unused. Second, even though it increased globally, the charge level still represents a low share in operators' costs, especially for SNCF (around 8%), whereas the evolution of traffic showed important shocks that seem to be much more related to the changes in SNCF's freight strategy. Indeed, reorganization plans, railway strikes, the liberalization of fret services and economic globalisation have extensively confused the price signal and impacted the traffics at a much higher degree than the relatively small signal of infrastructure charge could. However, set now at higher levels, and in a more stable environment, infrastructure charges may play a stronger role in the future.

Eurotunnel, having originally had a design capacity of approximately 10 million tonnes, has seen its rail freight traffic decline to just over one million tonnes in 2007. The original charges were devised in the midst of rail re-structuring in both Britain and France, with no actual reference to the market.

Furthermore, the monopoly and state aid aspects of the market rendered them irrelevant as signals to the market. Discussion between the key stakeholders led to another set of revised charges being announced in autumn 2007. Since the removal of state aid, opening up of the market and establishment of the new charging regime, traffic appears, on the whole, to be responding positively, though it is too soon to say whether this is a sustained turn-around.

The effect of changes in rail access charge regimes on rail and road traffic in Britain have been modelled using the Leeds Freight Transport Model (LEFT) (Johnson et al (2007)). By using LEFT, we have been able to explore the potential impacts of variations in infrastructure charging in isolation from any other changes that might impact on the rail freight market. We have found that by removing access charges, rail tonne kilometres (tkm) increase by 9%, reducing road traffic by almost 2 billion tkm, just 1%. This highlights an underlying lack of competitiveness of rail in key freight markets such as Food Drink and Agriculture and Construction, because of high captivity to road transport, given the short distances involved and the lack of suitable rail infrastructure. We have examined the sensitivity of the rail market to levels of access charges and found that rail is slightly less sensitive to access charge increases than it is to equivalent decreases. If we introduce different structures of access charging over distance bands, approximating a fixed and variable charging regime, we have shown how we can incentivise rail traffic over the longer distances where rail is more competitive and environmentally more beneficial.

Several conclusions can be drawn from the simulation modelling exercise. The possibility for IC differentiation between two sub-markets can stem from differences in costs or demand or market structure (or a combination of these features) of these services.

- In any case, IC differentiation brings small welfare changes when the two - or more- sub-market situations are close to each other; in such cases, the tiny improvement in welfare may lead to huge consequences on the distribution of welfare between the agents: the operators, the infrastructure manager and the consumers.
- Demand function differences –namely elasticities- have consequences never negligible and sometimes tremendous. The effect may depend on the nature of competition in the market.
- As far as costs are concerned, differentiation between two operators whose operating costs are different seems to bring minor welfare gains that could possibly be more important if these operators are monopolies than if they bear competition with another mode. In the case of two links whose infrastructure costs are different- or two operators whose damages to the track are different- differentiation may have observable welfare consequences and is to be recommended, especially when the operator is a monopoly; in the case of a duopoly, the market power of the operator is limited by the operator of the other mode and differentiation, though desirable, may be less important.
- A two part tariff bearing a term linked to the service (train km) and another one linked to the occupancy of the service (e.g. passenger km) seems to bring a non negligible welfare increase, to the extent of a change in its distribution: the infrastructure manager's revenue may decrease a lot as compared to a situation of purely linear tariff (proportional to the number of train km).
- In some cases, averaging the tariffs of several services may have important effects if these services have widespread characteristics of costs and demand; in particular, it may happen that the average tariff excludes some profitable services, ending up in a large loss of welfare.
- In case of a duopoly on track – meaning that two rail operators compete on the same track - welfare does not seem largely impacted by an averaging of tariffs.
- Last but not least, making non differentiated IC come closer to optimal IC levels could be much more worth than trying to differentiate finely around the initial IC levels if those levels are far from the optimal ones.

The main findings relating to the Regional Factors in Germany can be recapitulated as follows:

1. The introduction of the regional factors led to multiple reactions of public transport authorities. First, a part of the charge increase was integrated in passenger fares. Second, the higher the regional factor the lower is the purchased track kilometre. The reason for that development may

be found on the one hand in optimisation of passenger services and on the other hand in the possibility to use other transport means.

2. Passengers react predominantly inelastic to fare increases. The main reason for this is that qualitative travel elements (e.g. travel time) play a huge role in travel decisions.

3. The track access charging scheme of 1998 set as a two-part tariff comparatively better incentives for users to utilize more tracks. Its abolishment can therefore only be explained with competition and lobbying issues.

Additionally, an interesting observation is that track access charges in Germany lack of clear economical principles. Mainly charges are cost based. However, DB Netz uses demand arguments to justify several differentiation elements. The regional factors are one of these elements. A second one is the product factor for high utilized tracks. This fact is also confirmed by DB Netz officials. An assessment of such tariff schemes' effects is therefore complicated and requires sophisticated econometric analysis. Apart from researchers' difficulties tariff structures with no clear economical principles reveal the political dimensions of infrastructure charges. Additional differentiation elements are not classified under the company's main objectives, but rather under the real world needs to achieve political acceptability of the charging scheme.

Data availability issues have placed constraints on the level of analytical detail that we have been able to achieve. However, the case study research has helped to identify key trends and issues, whilst we have also been able to pursue some interesting modelling ideas. It is clear that modelling can help in identifying the cases where welfare curves could be quite flat (meaning that the final impact of IC level is rather low), and therefore in giving indications about the degree of desirability of infrastructure charge differentiation, given some minimal data requirements on the market segments concerned.

Besides data requirements, the research field of imperfect competition in rail markets seems to be quite important if we want to explore more these important issues and have a better understanding of what the final indirect impacts of infrastructure charging are, once interactions between competitors and demand converge to an equilibrium. Trying to open and explore this "black box" of interactions is highly desirable, since the very basic representations such as perfect competition assumptions are clearly far from being fulfilled.

Finally, it was agreed that a theoretical assessment be made to explore what data would, ideally, be desirable for a more analytical investigation into reactions in the future. One of the possibilities to calculate user reactions and elasticities in the railway sector would be via the use of aggregate models such as that used by Friedlaender and Spady. This approach is, relatively speaking, less data hungry than some alternatives, so in the current context of poor data availability, it perhaps presents greater opportunities for implementation. This kind of analysis has been applied very often for American railroads using publicly accessible data. If a data sheet with a similar structure to "*The Analysis of Class I Railroads"* were available for Europe then much more in-depth analysis could be undertaken.

1 INTRODUCTION

1.1 THE DIFFERENT PROJECT

In the European Union, levels and structures of transport infrastructure charges vary strongly across transport modes and countries. Some degree of convergence exists but, in the presence of unsolved practical and theoretical difficulties, any such convergence is slow. Moreover, the charging regimes that can be observed are often far from internalising external costs and are rarely based on efficiency principles. In this situation, differentiation of existing charges appears to be a sensible first step. DIFFERENT has investigated the possibilities of success for such an approach from a theoretical and empirical perspective.

The theoretical analysis aimed to reveal how much differentiation successful pricing schemes should exhibit, given that there are economic costs of price differentiation and problems of political implementation. The empirical analysis has focused on estimating elasticities and on case studies. Estimations have been carried out for freight and passenger transport on road, rail, water and air in a wide spectrum of European countries. The main basis for these estimations has been real-world case studies, new Stated Preference and Revealed Preference surveys and modelling work.

1.2 RAIL INFRASTRUCTURE CHARGING CONTEXT

Charging in the rail sector has, over recent years, made a number of moves towards greater efficiency and this has tended to lead to a greater degree of differentiation in the charges. A number of countries sought, as part of the reform of their national railway industries, to develop and implement systems of rail infrastructure charging that approximate to marginal cost pricing. Since adoption of Directive 2001/14 which requires rail infrastructure charges to be based on the marginal cost principle, the majority of member states have developed and implemented such systems of rail infrastructure charges. However, the ways in which Member States are basing their systems on marginal cost principles differ from one country to the next and a diversity of approaches has developed.

There has been relatively little research in the area of how train operators react to the charges they face. Instead, research has tended to focus on the design of infrastructure charging regimes which, in principle, promote efficient use of the infrastructure, efficient investment or which enable a particular degree of cost recovery. However, there is some evidence that train operator reactions to infrastructure charges are important. A key factor motivating the revisions to rail infrastructure charges in Britain in 2001 was the view that the initial system of infrastructure charges gave the wrong incentives to train operators and led to greater congestion on the network. User reactions were also a key factor in Germany, where the infrastructure charging system has undergone reforms largely motivated out of concerns about competitive incentives and user reactions amongst train operators.

Whilst concerns regarding user reactions have featured in the debate about infrastructure charging systems, they have not been the subject of detailed research. There is, for example, no previous research to estimate infrastructure charge elasticities and no research into how train operators perceive and interpret different charging structures; i.e. whether they can interpret highly differentiated, complex regimes or whether there may be a necessity to keep things simple. A further apparent gap in the research on rail infrastructure charges relates to the issue of how operators pass on their costs to end-users – that is, passengers and freight forwarders - and how different infrastructure charging regimes impact on charges to end users.

Several methodologies were considered to address these open research questions. Apart from econometric work on demand elasticities there have also been elasticity studies in the rail sector based on interviews. In Germany, for example, this methodology was used in the studies by Baum, Gierse and Maßmann (1988). Studies using this kind of approach may serve as a useful check on the reliability of econometric estimates. They are also likely to be required where historical or panel data is unavailable or does not exhibit sufficient variation to enable meaningful correlations, e.g. via regression techniques.

One can postulate that rail infrastructure charges might have two principal effects on train operators. Firstly, they might affect their behaviour, in terms of their use of the infrastructure and the way they operate their services. That is, a train operator's decision as to whether to offer a rail service and how to offer that service – when, where and with what rolling stock, staffing levels etc – is likely to be affected by the charges that they will incur in doing so. If there is a differentiated charging system featuring relatively high infrastructure charges in peak times (as was proposed in Britain) or on highly utilized lines (as is the case in Germany and Austria), that may serve as a disincentive to an operator considering the introduction of a new or additional peak service. Correspondingly, relatively low charges at night, for example, or on less utilized lines are likely to serve as a stimulus to new or additional services. Secondly, rail infrastructure charges could be expected to affect the charges that train operators make to their customers, be they passengers or freight forwarders. In fact, there may be a feedback mechanism, whereby the charges that train operators are able to make to their customers has an impact on the rail infrastructure charges as well. For example, if a train operator is faced with a high infrastructure charge for operating a particular service but thinks that passengers place a high value on that service, they might decide to operate the service on the basis of being able to cover the cost of the infrastructure charges through charging high passenger fares. Indeed, the reason behind the high infrastructure charge for that service may actually be a factor of the value that train operators believe that their customers place on the relevant rail services.

There are likely to be differences between reactions and impacts within the passenger as compared with the freight market. Freight is, in European rail systems, often a marginal activity, which is fitted around the passenger services. Freight may be more flexible, at least for some flows, in that the time windows it operates in are less constrained than for passengers. Furthermore, freight tends to be, and it would appear to increasingly be, more international in its nature than passenger services. This then leads to the necessity for operators to interpret several, sometimes very different, systems of infrastructure charging as they pass through two or more countries.

The diversity of infrastructure charging regimes that exist throughout Europe is, in one sense, a good opportunity to undertake comparative research in this area. That is, Europe provides a real world laboratory, in which the attributes and impacts of one system can be compared and analysed in relation to one or more others. However, it is not only infrastructure charging regimes that differ across different countries; differences in respect of subsidy to the industry, regulation of the industry, market entry and competition serve to cloud the issue somewhat. Hence, there is a rich set of situations to draw on for research purposes, but with this comes a set of varying contexts that need to be controlled for somehow.

1.3 WP7 – Effects of Differentiated Charges on Railway Operators

The investigation of differentiation of charges in the rail sector is concentrated within Work Package 7 of the project. This work package aimed to develop a better understanding of the ways, in principle and in actuality, in which users react to differentiated charges in the rail sector and propose a methodology for determining appropriate levels of differentiation. Six case studies were drawn from those Member States that have been most active in the areas of rail charging.

There are, in actuality, two relevant sets of charges in relation to rail:

1. Charges levied by infrastructure managers on train operators; and
2. Charges levied by train operators on 'end-users', that is on passengers or freight forwarders.

Our research focuses mainly on rail infrastructure charges, rather than on charges to end-users, on the basis that there is less existing research into reactions to rail infrastructure charges and that it is this area that is thought to be more directly relevant to the European Commission. Nevertheless, we also consider the latter, in part because of the link that one might expect there to be between charges faced by and levied by train operators and, secondly, for any insights that may be relevant for rail infrastructure charges.

The objectives of the work were as follows:

- To develop a better understanding of how users and, to a lesser extent, end-users react to differentiated charges in the rail sector – that is how train operators react, in terms of their choices about vehicle type, route, volumes etc, to differentiated rail infrastructure charges and, to a lesser extent, how passengers react to rail passenger fares and freight forwarders react to freight forwarding charges.
- To investigate the limits to the differentiation of charges, in terms of users' capacity to react, geographical issues, equity considerations etc.
- To contribute to a methodology for determining the appropriate degree of differentiation and, specifically, to use this methodology to make recommendations as to the appropriate level of differentiation of charges in the rail sector – balancing the needs to manage traffic levels, minimise external costs and meet revenue requirements.

The work has been organised into four sub-tasks:

- Task 7.1 – Selected Practice
- Task 7.2 – The Freight Market
- Task 7.3 – The Passenger Market
- Task 7.4 – Inter-relationship between passenger and freight market.

1.4 Findings From the First Phase of Work

An interim report, D7.1, preceded this deliverable. It comprised a review of the policy and academic literature, a series of case-study investigations, including a round of 25 interviews with industry stakeholders, and a review of research methodologies that might be employed.

One early finding was that, whilst infrastructure charges are a potential influence on train operator behaviour, other cost elements for train operators (staffing costs, train operating costs etc) and demand elements (demand reactivity to price levels, to quality of service, willingness to pay, etc) would also be expected to be important influences on the market. Furthermore, the rail market is also likely to be affected by a host of contextual factors, including the competitive and regulatory framework (monopoly or oligopoly, type of regulation) and levels of car ownership and economic growth.

Secondly, whilst we were able to gather information about infrastructure charge categories and levels for the selected case study countries, we very often encountered a lack of even the basic information about precise infrastructure charge quantities (i.e. train-paths, or train-km) bought for each category. Many of the other elements are viewed by train operators as being commercially sensitive; even the price levels are often not precisely observable, due to yield management techniques introduced in preparation for competition in the rail market.

Hence, it was concluded that a systematic analysis of the impact of infrastructure charge differentiation seems an extremely difficult prospect at this point. Disentangling the impact of charges from the impacts of all of the other significant influences on the rail market, amidst a diversity of charging regimes and contexts, with a limited supply of detailed data, would appear to be highly problematic.

The rail market is comprised of many different sub-markets, and there are potentially different scales of impacts in different sub-markets. In actuality, it appears to be the case that, in many situations, operators have relatively limited scope to adapt their supply policy and their tariffs in response to infrastructure charges. For instance, where services are franchised, e.g. as is the case with regional passenger services in Germany and with nearly all passenger services in Britain, services are quite closely defined by the terms of those franchises. Hence, there is limited scope for operator response to infrastructure charges during the life of the franchise. However, charges may serve to influence the terms of franchises, either through franchising authorities examining the implications of the charges for the services they wish to specify or through the terms of the franchise bids submitted by competing operators. This mechanism for response, being contained within the planning process, is very difficult indeed to tap into.

In some situations, there may be no reaction at all on the part of train operators, due to mechanisms of compensation being in place. For instance, again where services are franchised it is common (and reasonable) for the terms of that franchise to require operators to be compensated by the franchising authority for any changes in infrastructure charges during the course of the franchise. Again, it may be possible to tap into the impacts as they relate to the franchising authority, but this would again be expected to be problematic.

Nevertheless, whilst reactions may be difficult to analyse and, in certain situations, relatively limited in scale, our interviews did uncover which sorts of parameters have been affected. Main reactions observed were in relation to:

- Design and choice of rolling stock;
- Suppression of unnecessary path reservations when reservation charges were introduced in France;
- Increased use of high capacity rolling stock when peak-hour differentiation was introduced in France (still, as mentioned above, other factors did influence this evolution).

There was some interesting discussion of the share of train operating costs comprised of infrastructure charge-payments, and we have come to the view that the scale and form of reaction to infrastructure charges is likely to depend crucially on these cost shares. The cost shares for the use of infrastructure vary markedly across the interviewees in different countries. In general, the share of infrastructure charge costs as a proportion of train operating costs was reported to range between 10% and 30%. However, in Sweden the cost share was estimated at approximately 5%, whilst in Germany some operators estimated it to be as high as 60%.

Almost all participants indicated elasticities greater than one. There are reasons to doubt whether elasticity in all cases is greater than one, since the interviewed persons represent at the same time the interests of their industry, and therefore it is natural that interviewed persons in such cases tend to exaggerate.

Interestingly, on a number of occasions, operators reported that current degrees of differentiation were actually insufficient to elicit a reaction. For example, according to the opinion of the participants in Austria and Germany, the differentiation for high utilized tracks seems, due to the higher operative costs of the lower charged tracks, to miss its goals. Apparently there would be effects recognizable, if there was a higher degree of differentiation. Furthermore, many operators reported that they would be ready to accept higher charges in exchange for better quality of service.

In all of our sets of interviews, freight operators indicated a greater degree of sensitivity to infrastructure charges than did passenger operators. In general rail freight tends to be privately operated, is confronted with severe competition from the road, has experienced more open access competition and receives less government financial support, than do passenger services, and together these factors may explain this apparent greater degree of sensitivity. In Britain, for example, there has been significant growth in the rail freight market since infrastructure charges for freight operators were revised – incorporating a marked reduction in their level – in 2001. The extent to which this growth is as a result of this revision is, however, not clear as other changes in the market have occurred simultaneously; nevertheless, it potentially offers an interesting line of further enquiry.

An initial hypothesis was that one of the impacts of differentiated infrastructure charges would be on prices charged to end-users – passengers and freight forwarders. In some cases, e.g. where services are franchised and infrastructure charges change during the course of the franchise, it seems clear that any such impact on prices to end-users is minimal or non-existent. Beyond this, it would seem that there would be some impact, but that this impact would be heavily influence by the degree of external competition – be that from other rail operators or from other transport modes - in the end-user market. In general, the greater the degree of external competition the smaller the likely impact of infrastructure charges on prices to end-users. Indeed, the level of external competition often appears to be more important in determining end-user prices than infrastructure charges

Finally, it must be noted that the data situation with respect to user reactions to differentiation of track access charges in rail is very problematic. Certainly, the charges themselves are public (although in freight some are the subject of private contracts) but the necessary data to analyse the reactions of the train operators with respect to output quantity (e.g. train kilometres), prices, costs and adjustment of production processes (choice of path or of type of rolling stock etc.) are extremely unsatisfactory or none existent.

We identified a number of potentially fruitful lines of further enquiry that could be followed in relation to this topic. For further systematic analysis in this area, one might, ordinarily, seek to employ some form of econometric or statistical modelling exercise. However, for this, one would require detailed cost and demand statistics at the train operator level, and this would appear not to be available to us. Alternatively, one might seek to employ some form of methodology that could be implemented using less-detailed data. The key options comprised:

- More research into the changes in the freight market in Britain. There has been a lot of rail freight growth in Britain since significant revisions to the infrastructure charges implemented in 2001, and it was thought possible to investigate the extent to which these are linked.
- Examination of the structure and level of Eurotunnel infrastructure charges and their impact on British-French international traffic - given the apparent significance of charges for freight and the relatively high charges for freight through Eurotunnel, an investigation of impacts could be very interesting
- Further research on the effects of the introduction of regional factors in Germany. The introduction of 'regional factors were highlighted in the interviews as having been controversial. The regional factors are surcharges (or discounts) on the basic track access charges depending on the character of the local networks that are involved in using a certain path. Given, however that these regional factors are only a small percentage of the total track access charge we should not expect very substantive effects on the train operators' behaviour.
- Simulation modelling, involving representation of the downstream market could also be possible - Quinet and Meunier make 2 very interesting contributions. Quinet's involves several specifications of competition situations and demand curve types, whilst Meunier has proposed to use a unique parameter that sums up the influence of competition and regulation conditions: with basic demand curve types, they obtain simple expressions for the reactivity of price or quantities to infrastructure charge. It is also possible, in this kind of approach, to represent the influence of other elements of train-operator behaviour. For instance, Quinet treats explicitly, in one case, the trade-off operators may have to make between their consumption of train-path and their traffic revenues, through the choice of train frequency.
- Further research into theoretical work to examine the mechanisms of user reactions and the variables most likely to be impacted upon in principle. This could enable a detailed specification of data requirements for the robust assessment of elasticities with respect to infrastructure charging. This could be combined with a discussion of which measures the relevant regulatory bodies and the European Commission could take to make such data available.

1.5 THIS REPORT

This deliverable is the final report of the workpackage. Given the difficulties outlined above, particularly in relation to data, it was agreed that the final phase of the work package pursue the following streams of work:

- Case study work focused on the Freight market in Britain;

- Case study work focused on the freight market in France;
- Case study work focused on rail freight through Eurotunnel;
- Modelling work based on the freight market in Britain;
- Simulation modelling of the downstream market using Quinet and Meunier's techniques;
- Case study work on the role of Regional factors in Germany;
- Case study work to analyse impacts in relation to passenger fares in Germany; and
- A review of passenger fares elasticities and attitudes to different fares structures.

This work is reported on in the following two chapters. Our conclusions are then set out in a fourth and final chapter.

2 REACTIONS IN THE RAIL FREIGHT MARKET

2.1 INTRODUCTION

Having found, in the first phase of the work, that freight operators indicated a greater degree of sensitivity to infrastructure charges than did passenger operators, we have concentrated much of our attention in the second phase of work on the freight market. As referred to above, rail freight tends to be privately operated, is confronted with severe competition from the road, has experienced more open access competition and receives less government financial support, than do passenger services, and together these factors may explain this apparent greater degree of sensitivity.

Our further investigations have focused on rail freight in Britain, in France, through Eurotunnel and in Germany. For Britain, France and Eurotunnel, we have undertaken case study analyses of changes in the rail freight market in order to make informed observations regarding potential linkages between changes in the infrastructure charging regimes and changes in rail freight traffic. For Britain, we have also undertaken aggregate modelling to test a number of charging scenarios for their impacts. For France, we have also explored variations in infrastructure charging by use of simulation modelling incorporating market competition. For Germany we have studied the effects of the different German track access charging regimes on investment and demand by abstracting from reality and considering an exemplary track, though as this analysis is somewhat different and distinct, we have included it's detail in an appendix.

2.2 OBSERVATIONS OF REACTIONS IN THE BRITISH FREIGHT MARKET

Up to the point of rail privatisation which commenced in 1993, the demand for rail freight had been on a 40-year downward trend. However, having reached a low-point in 1995, demand has grown over the subsequent 10 years for which we have data. There has been an increase in rail freight over the last ten years from 15 billion tkm moved in 1996 to 22 billion tkm in 2006. In terms of the total growth in freight across all four modes illustrated, there has been an increase of 189% from 1953 to 2005.

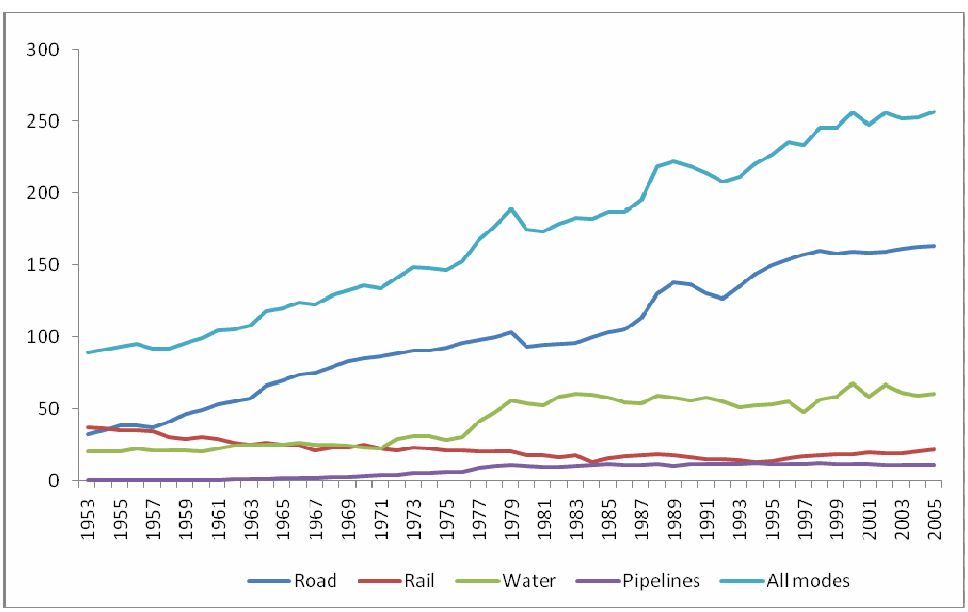


Figure 2-1 Domestic Freight Transport Moved (Billion Tkm) by Mode 1953-2005

Source: Transport Statistics Great Britain 2007

Privatisation established a series of privately-owned open access rail freight operators, required to pay Track Access Charges to the infrastructure manager for the use of the network. During this period there have been 2 sets of infrastructure charges in place for freight operators. The first framework of charges for freight train operators was put in place in 1995. This framework remained in place until 2001, when the first Periodic Review of Track Access Charges recommended substantial changes be made.

The first charging framework, introduced in 1995, was a negotiated two-part tariff, based on the value to each user of using the infrastructure, subject to the constraints of covering avoidable costs and avoiding discrimination between operators competing in the same sector. A charge 'floor' and a charge 'ceiling' were established. The floor was based on the avoidable costs, whilst the ceiling was based on standalone costs, I.E. those costs that '… would be incurred by a notionally efficient competitor providing a dedicated network for the service(s) in question.' (ORR, 1997, cited in Stitle, 2004). In fact, the two-part tariff comprised a large fixed component and a relatively small variable component. The average track access charge under that framework payable by freight operators was estimated as being approximately £6.23 per thousand gross tonne miles (kgtm), whilst Railtrack's freight-specific costs were of £5.53 (CFIT, 2001).

By 2001, gross tonne mileage had increased by more than 35% and additional growth was anticipated. Indeed, the government had set out an ambitious strategy for increasing demand for rail freight, with a target of achieving 80% growth over the period 1998/99-2010 and, with this in mind, a number of new operators were considering entering the market. Concurrently, rail freight was thought to be facing increased competitive pressures from road and other modes. For example, decisions to allow the operation of 44 tonne lorries and to stabilise vehicle/fuel duty were considered to be giving road haulage a significant competitive advantage. Furthermore, the periodic review of access charges for franchised passenger train services had the effect of changing the balance of incentives between rail passenger and freight services on the network.

These changes in rail freight market conditions led the Regulator to conclude that it was appropriate to undertake a review of the freight charges. Crucially, a better understanding of cost causation had developed, meaning that there was a stronger body of evidence on which to base a new set of charges.

Prior to the outcome of the Periodic Review of Track Access Charges in 2001, an independent government advisory body, the Commission for Integrated Transport (CFIT) established a Rail Freight Working Group to consider track access charges. CFIT believed that rail infrastructure charges for freight services were "a significant factor for the further expansion of the domestic freight market". In particular, their view was that the high costs of track access were serving to hold back rail freight operators from diversifying into non-bulk traffic. They commissioned research to analyse how rail freight operators could set about achieving the Government's target of growing the rail freight market by 80% by 2010, with particular attention given to the influence of the amount paid for track access.

This work identified infrastructure charges as one of seven key issues associated with growing the rail freight market and estimated the level of track access charges which would need to apply, under various scenarios, to deliver the Government's 80% growth target. Under a central scenario, which assumed relatively small improvements in rail service efficiency, and continued decline in road haulage journey times (and efficiency), they estimated that an average track access charge of £3.50 per kgtm would deliver approximately 80% growth by 2010. This implied almost a halving of the then average track access charge. Under a "worst case" scenario, assuming no improvement in rail service efficiency or journey times over road haulage, they estimated that an average track access charge of £1.50 per kgtm would be required to deliver the same volume of growth by 2010.

The outcome of the 2001 Periodic Review represented a fundamental shift away from a negotiation-based approach to a published set of charges, the stated aim of which was to reflect the variable costs to the infrastructure manager of freight operations. The intention was that this would reduce transaction costs, improve operators' ability to plan their businesses and create a more level playing field for new and potential freight operators.

A fundamental change involved the Regulator no longer requiring that freight operators be expected to pay either fixed freight costs or the infrastructure manager's costs which are common between freight and passenger operations for use of the existing network. The charges comprised three components:

- Usage charges – designed to reflect infrastructure wear and tear costs directly attributable to particular services;
- Traction electricity charges – designed to relate directly to the amount of electricity consumed by any particular vehicle; and
- Capacity charges – designed to broadly reflect the congestion costs associated with increases in capacity utilization.

The effect of these changes was that, on average, the charges that freight operators paid to the. infrastructure manager were halved. The resulting shortfall in revenue to the infrastructure manager from freight operations, which was estimated as being £500 million over a 5 year period, was to be funded by the government (via the Strategic Rail Authority). In addition, performance regime arrangements were put in place to provide both freight operators and the infrastructure manager with an incentive to reduce the delay which they impose on users of the network.

Interestingly, the outcome of the Periodic Review was very close to the charges associated with the 'central scenario' examined in the work for CFIT. It is, therefore, revealing to examine the growth in the demand for rail freight and how that compares with that projected in the CFIT work.

The trends in commodities moved by rail over 1998-99 to 2006-07 are illustrated in Table 2-1. It shows that, across all commodities, there has been a growth of 28%. Within this, it is notable that coal traffic has almost doubled and construction traffic has increased by a significant 29%.

Table 2-1 National Railways Freight - Freight Moved by Commodity 1998-99 to 2006-07 (Billion Tonne-Kilometres)

	1998-99	1999-00	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07
Coal	4.5	4.8	4.8	6.2	5.7	5.8	6.7	8.3	8.8
Metals	2.1	2.2	2.1	2.4	2.7	2.4	2.6	2.2	2.1
Construction	2.1	2.0	2.4	2.8	2.5	2.7	2.9	2.9	2.7
Oil and petroleum	1.6	1.5	1.4	1.2	1.2	1.2	1.2	1.2	1.5
Other traffic	7.1	7.6	7.4	6.7	6.6	6.8	7.0	7.1	7.0
All traffic	17.3	18.2	18.1	19.4	18.5	18.9	20.4	21.7	22.1

Source: Transport Statistics Great Britain 2007

Table 2-2 illustrates the trends in rail freight lifted for coal, other traffic excluding coal, and of all traffic over the period 1998-99 to 2006-07. It shows a decline over the first part of the period, followed by an increase, resulting in an overall growth over the period of 6%. Linking this to the numbers presented in Table 1, this indicates that rail freight growth has been associated more with an increase in the distance freight is moved than the actual quantity of freight being moved. In terms of coal, despite the increase in tkm in 1998-99 to 2000-01, there has been a decline in tonnes lifted. Despite the 29% increase in coal tkm in 2001-02, tonnes lifted only rose by 12% in that same year. In the years that followed, changes in coal tkm were also characterised with changes in tonnes lifted in the same direction. However as coal tkm rose from 8.3 to 8.8 billion from 2005-06 to 2006-07, tonnes lifted decreased slightly from 48.9 to 48.8 million over that same period. In terms of all rail freight traffic lifted over the last decade, the lowest point was in 2002-03 where only 87 million tonnes were lifted.

Table 2-2 National Railways Freight - Freight Lifted by Commodity 1998-99 to 2006-07 (Million Tonnes)

	1998-99	1999-00	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07
Coal	45.3	35.9	35.3	39.5	34.0	35.2	44.0	48.9	48.8
Other traffic	56.8	60.6	60.3	54.5	53.0	53.7	57.1	58.7	59.6
All traffic	102.1	96.5	95.6	93.9	87.0	88.9	101.1	107.6	108.4

Source: Transport Statistics Great Britain 2007

Thus, whilst charges were essentially halved in 2001, growth in rail freight demand is not proceeding in line with the 80% government target (as the CFIT projections estimated that it would). Having grown by an impressive 4.8 billion tonne-kilometres between 1998-99 and 2006-07, it would have to grow by a further 9 billion tonne-kilometres over the next 3 years in order to achieve this target. This then begs the question of how the assumptions of the CFIT 'Central scenario' compare with what has actually occurred since 2001. Certainly a number of unforeseen events have taken place over the period, including the closure of a major steel works (reducing demand for both coal and steel traffic), the switching of postal services from rail to road and the essential break down of the Strategic Rail Authority's freight strategy. However, it is tempting to conclude that perhaps the CFIT work over-stated the importance of the role of infrastructure charges in stimulating rail freight demand.

Nevertheless, there has been considerable growth in rail freight over recent years and infrastructure charges are likely to be partly responsible for this. Indeed, commentators have tended to site six factors as explaining the growth since 1995, as follows:

- Increased road congestion;
- Increased costs for road freight arising out of the fuel duty escalator and, more recently, the Working Time directive;
- An increase in coal imports;
- Improved quality of service for rail freight;
- Investment in rail freight facilities;
- Infrastructure charge changes.

In terms of the types of commodities transported, there has been strong growth in some sectors. This has been most notable in relation to coal, which rail is inherently better-suited to carrying. The movement of coal and coke currently dominates rail freight, and 87% of coal and coke were carried by rail in 2006 (MDS GB Freight report 2006). However, it is thought that, for coal, transport accounts for only approximately 5% of the price of delivered coal, so the market is thought to be relatively insensitive to changes in the costs of transport. Hence, the actual growth in coal tonnes lifted was probably not related to the regime of infrastructure charges, but more concerned with changes in the detail of the power-generation market. The charge reductions may have enabled length of haul for coal and other traffic to increase at relatively little expense. Length of haul for coal traffic, for example, increased by 15% between 2001-02 and 2006-07. However, on inspection, this seems to simply be the continuation of a trend that commenced prior to 2001. The average length of haul was 120kms in 1980 and had risen to 206kms by 2004 (MDS GB Freight report 2006).

There has also been quite strong growth in construction traffic. In contrast to coal, the construction market is thought to be very price sensitive, with transport accounting for as much as 50% of the price of delivered materials. Hence, it is likely that charge reductions would stimulate growth in construction traffic. However, construction traffic since 2001 has fallen, then risen and, most recently, fallen again to a point slightly lower than that in 2001. It must be concluded that if carriages are having an impact on this market, some other factor is clearly having an offsetting impact.

Rail freight growth actually started in 1995, and we do not observe a major change in the trend around the time of the reductions in infrastructure charges introduced in 2001. Prior to 2001, the structure of charges was such that there was a large fixed charge which, once paid, provided an incentive to operate as much as possible. Post 2001 the structure no longer provided this incentive but it did allow for increased competitiveness, but the level was such that it enabled the rail freight market to remain buoyant. It is thought that, initially, charge-reductions were only passed on to clients in a limited way – so part of the reduction was enjoyed by the operators as windfall gains. Then, once contracts with clients were renegotiated, the reduction in charges were past on as reductions in charges to clients. Furthermore, differentiation by vehicle-type is thought to have has focused the industry on track-friendly bogies.

As the rail freight industry has become more competitive and cost-conscious, it is rational that operators will pay more attention to what they are being charged for access to the infrastructure. It is suggested that this will have alerted operators to possible arguments for reduction of charges. Such arguments may have an effect on the overall charge level, as the rail freight industry has a strong incentive to make robust representations to the charge-setting authorities. They might also relate to incentives for operators to reduce impact of rail freight on the network, e.g. by operating less-damaging rolling stock, by requiring fewer slots to operate a particular service etc.

2.3 Observations of Reactions in the French Freight Market

Infrastructure charges in France were first implemented in 1997, at which time the French infrastructure manager, Réseau Ferré de France (RFF), had just been set up. The network was divided into track categories and the charging components were established as follows:

- DA - a fixed access right;
- DR - a path reservation fee;
- DC - a charge for train circulation; and
- Additional charges, such as for the use of electrical supply equipment and access to marshalling yards.

RFF was not then able to make a precise bill to SNCF, the only rail operator on the French network up to 2005, so the charging regime comprised a global package based on traffic, up to 2002. Hence, no freight or passenger trains had any marginal infrastructure charge to pay until 2002. Therefore, whereas the evolution of the total charges paid may be observed from 1997, the evolutions of unit price levels have to be made on the basis of 2002 or later years.

There have been several changes to charging structure and levels over the period. The level of charges was increased extensively in 1999, but this increase was chiefly focused on passenger traffic, with only a 2% increase in freight charges. Freight traffic decreased slightly (-1%) in 1999, then increased by 6% in 2000 before decreasing again in 2001 by some 9%.

From 2002 on, the structure of charges is stable and gives marginal charge levels' signals to the operator(s). Yearly arrêtés from the Ministry of Transport set the charging regime for one year and, generally, charge levels are known at least one year in advance. Given this level of pre-announcement, we assume that demand can adapt more or less to these evolutions with no important delay, allowing us to compare directly yearly traffic and tariffs. Additional charges such as those applying for the use of marshalling yards are not covered by these arrêtés.

The arrêté setting the 2002 charging regime defined the track categories, as set out in Table 2-3.

Table 2-3 RFF Track Categories

Track category	Subclasses	Length	Designation
Urban and suburban lines	High level of traffic	287 km	A
	Medium level of traffic	985 km	B
Main interurban lines	High level of traffic	7,209 km	C
	High level of traffic and max. speed 220 km/h		C*
	Medium level of traffic	5,840 km	D
	Medium level of traffic and max. speed 220 km/h		D*
Other lines		12,738 km	E
High-speed lines	High level of traffic	718 km	N1
	Medium level of traffic	457 km	N2
	Mediterranean HSL, medium level of traffic		N2*
	Low level of traffic	321 km	N3
	Mediterranean HSL, low level of traffic		N3*
	East-European line	300	N4

Note: the length per track category actually changes slightly from year to year.

Key aspects of the charging regime introduced in 2002 are as follows:

- DA is zero for D and E track categories. It is 365.88 €/path-km used per month for A & B, and 3.05 € for C track category.
- DR is composed of a reservation fee (DRS) and a 0.6 coefficient (coefficient K) for freight trains (this means that freight trains get a 40% rebate on path reservation fee in return for lower quality paths – quality of passenger trains being consistently favoured). The levels of this charging component are set out in Table 2-4.

Table 2-4 DRS Tariffs for Conventional Track Categories in 2002 (€/Path-Km)

	A	B	C	D & E
Off-peak hours	1.52	0.61	0	0
Normal hours	4.88	1.22	0.8	0
Peak hours	14.3	2.44	0.8	0

DC is set lower for freight trains than for passenger trains (0.23 €/train-km vs. 0.79), whilst a fee for power transport (RCTE) is created. Like the use of electrical supply equipment (RCE) and the use of marshalling yards, etc., it is an optional service. Rail freight traffic remained stable.

In 2003 DA was increased slightly for track categories A and B, but a coefficient M was created for differentiating this access fee, for A, B and N track categories, varying with the number of reserved paths and the duration of the agreement for those paths, as set out in Table 2-5. Total DA paid decreased (86 M euros i.e. 4.7% of total charges vs. 95 M euros and 5.2% in 2002).

Table 2-5 M Coefficient for Access Fee DA

Coefficient M	Number of booked paths in A, B, N			
Per category	1-10	11-100	101-1000	>1000
Purchase agreement < 5 years	0.03	0.225	1.5	1.5
Purchase agreement > 5 years	0.02	0.15	1	1

Furthermore, coefficient K was divided into 2 categories: K=1 for train paths > 300 km with an average speed > 70 km/h (meaning no rebate for these "rapid" trains, that correspond roughly to "high value" freight such as containerised traffic), and K=0.6 for all other freight trains. In addition, all DRS and DC tariffs increase by 2 %.

Freight traffic decreased by 6.4%, but it is understood that this was mainly due to a long strike during the spring. SNCF freight branch's losses reached 450 M€[1]. A 3-year restructuring plan, the Plan Fret 2006, is implemented. It aims at focussing on heavy-haul, profitable services, and defines a new strategy based on customer approach and a better quality of service. SNCF forecast that they would obtain financial balance in 2006 and expected the traffic to decrease under 35 billion tkm.

Then in 2004, DA's structure was modified by an arrêté, in readiness for the imminent arrival of new rail operators. For each path, DA became the product of the length of each network section used and a fee per path km. This new structure applied from 2006 on. Also, DRS of less expensive categories increased slightly. Zero terms were suppressed except for E off-peak hour category, but their level was still low (D= 0.01 to 0.05 €/path-km and E= 0,005 €/path-km). On the contrary, the increase was important for C category: + 60 % in normal hours (0.13 €/path-km), and multiplied by 15 in peak hours – still, the level remains quite low (1.25 €/path-km). A and B remain quite stable. In addition, DC freight increases by 3 %.

Freight traffic remained more or less stable (increased by 1 % in tonnes but decreased 1% in tkm). The Plan Fret seemed to achieve its 2004 target results, but traffic doesn't fall under 40 billion tkm. The marshalling yards/ freight courtyards system was revised. Quality of service and productivity indicators showed a little improvement despite the increase of energy costs and important reorganisations in the industry. Some shippers report that SNCF's freight tariffs doubled, or even were multiplied fourfold without prior consultation. All these evolutions of SNCF's services and prices have in 2005 an overwhelming impact compared to the marginal impact of infrastructure charge evolution.

In 2005, conventional track categories (A to E) are not much affected by 2005 DRS rises, except for C which DRS gets almost quadrupled (x 3,7) for off-peak hours and tripled for normal hours (0.38 €/path-km for both tariffs). DC freight increases slightly but remains about 1/3 of DC passenger.

Freight traffic decreased by 12%, but it is understood that this was largely due to Plan Fret's rationalisation. After a long controversy, the European Commission approved the 800 M€ State aid for SNCF freight branch reorganization. SNCF is already running late with the financial and quality objectives.

The modifications of DA structure's that were introduced in 2006 means that it is not possible to define its change in level from previous years. Although DA's share in total charges is very small (around 4%), this modification was necessary in order to allow the development of new entrants' traffic in a non-discriminative way –the package term would obviously have favoured SNCF. DA for conventional track categories was 0.015 €/ path-km, except for D and E, which were zero. In addition, DRS increased by 4 % in B off-peak hours (0.65 €/path-km). C off-peak and normal hour tariffs were aligned on this tariff (+70 %). Furthermore, DC freight increased by 15 %.

Freight traffic remained stable. However, Plan Fret's objectives, even after downward revision, were not achieved, and the freight branch ended the year with 260 M€ losses. Shippers pointed out a

[1] Source: SNCF

downfall in quality –especially punctuality on the second half of the year. CNC, the main rail-road container operator owned by SNCF, was restructured and focused its activity on maritime containers, abandoning most other market segments.

In 2007 DRS' main increase was concentrated on A off-peak hours (19 %) and C peak hours (20 %). In addition, DC Freight increased by 33 % (0.4 €/train-km). The freight branch launched a second reorganization plan in the August, focussing on single wagon traffic. This traffic is to be handled through 3 main "hubs" –Villeneuve-saint-Georges (Paris), Sibelin (Lyons), Woippy (Metz)- and 31 regional yards, 262 courtyards (mainly located in Centre and Poitou-Charentes regions) being closed to single wagon traffic. Since this new organization was to be implemented within only 3-months following the announcement, shippers were forced to use emergency alternatives and local governments were alarmed. Strangely enough, the announcement was made while the Government organised the great debates of "Grenelle de l'Environnement", that planned for non-road transport modes a +25% market share increase. Besides this, the strikes following the special working regimes reform in France, that highly concerned SNCF's workers, brought on an estimated 80 M€ loss to freight branch.

Thus, there have been a number of modifications to infrastructure charges in France over the past decade, as well as some industrial upheaval arising out of reorganisation and new competition. Identifying clear and distinct impacts of these factors on the demand for rail freight would always be difficult, but the lack of data from the two main sources, SNCF and RFF, has been a major problem. Had it been possible to get the figures of quantities bought by rail operators for each type of tariff, we could have realistically sought to extract some kind of statistical link between tariffs and quantities bought. However, as it is, all that is possible is to draw some broad indications.

In drawing any conclusions, we should recall that low-value freight traffic cannot bear high prices and is not very sensitive to transit time; therefore it is more likely to use low quality paths and thus less expensive track categories, especially D and E. Still, two of the three main marshalling yards - Villeneuve-Saint-Georges (Paris) and Sibelin (Lyons) - are located on category A sections, so that a notable part of freight traffic cannot avoid running on the most expensive track category. Except for a few postal TGVs, freight trains cannot run on high-speed (N) lines. Freight trains are also more likely to use off-peak paths during the night.

As a whole, the increase of infrastructure charges for freight is important (see Table 2-1) but less apparent than for passenger traffic. RFF's global revenue for freight showed a 5 % increase from 1997 to 2004 with a 29% decrease in traffic (in tkm). The most important evolutions are those of track category C, coefficient K applied to reservation fee DRS, and circulation fee DC. The access fee DA decreased and remained stable at a low level since its new 2006 variable structure for all conventional (non-N) categories.

DRS increased mainly for track category C: A increased by 11% from 2002 to 2009, B increased by 28 % and C was multiplied by 15. D an E tracks began to pay a reservation fee in 2004. E tracks remained stable up to 2009 and D increased by 3%. DRS increased mainly in 2005, for C tracks only. Peak hour tariff remained around 1.9 times the normal hours tariff from 2002 to 2009. But off-peak hour's coefficient increased from 0.27 to 0.42 during the same period, concerning more specifically freight trains. Indeed, the level of time differentiation has decreased during this period.

Coefficient K has been modified in order to introduce a willingness to pay criterion, introducing a differentiation between "rapid" (high value) freight traffics and other freights. DC for freight doubled between 2002 and 2009. While freight infrastructure charges went up as described, freight traffics went on a downward trend from the end of the 1990's (see Figure 2-2, Figure 2-3 and Table 2-6). These evolutions may seem, at first sight, to be closely related.

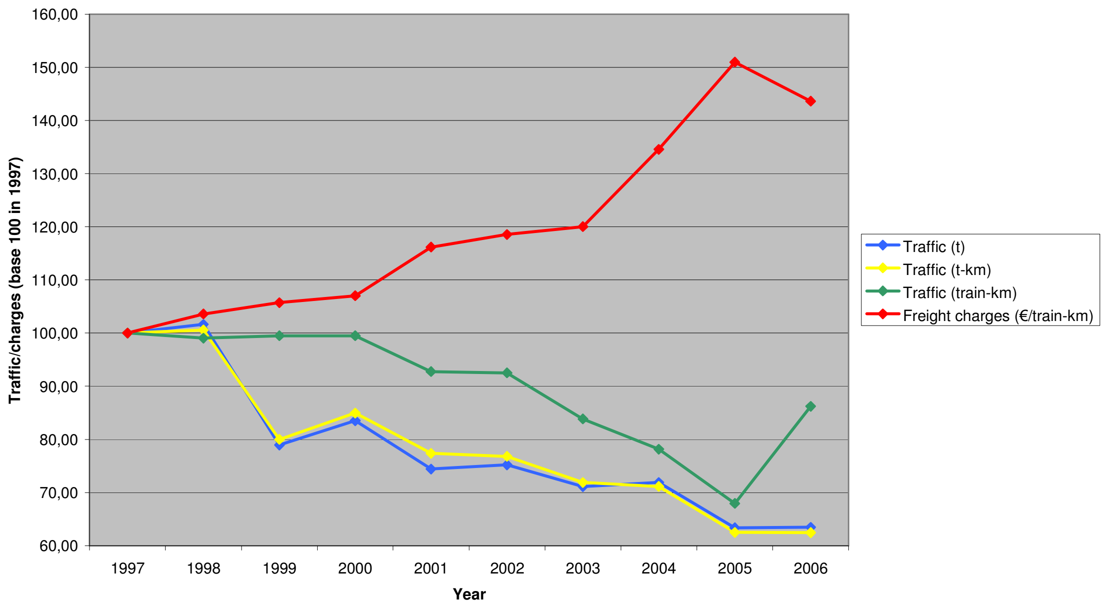


Figure 2-2 Freight Infrastructure Charges and Traffic Indicators from 1997 to 2006 (Base: 100)

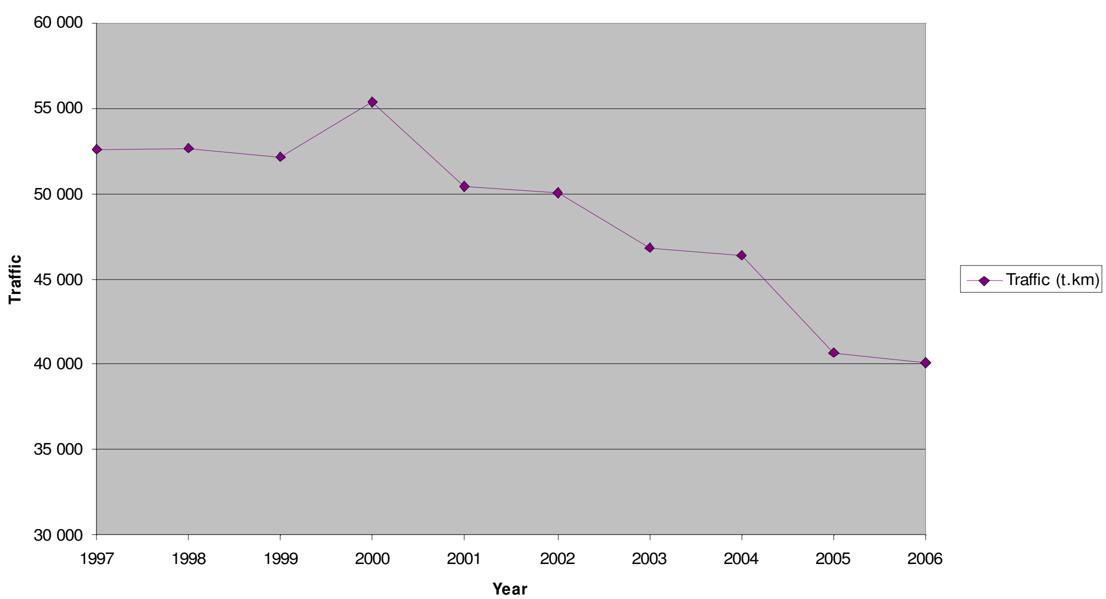


Figure 2-3 Freight Traffic (Mt-km) from 1997 to 2006

Table 2-6 Charges per Freight Train-Km from 1997 to 2005

	Total Freight Charges (M€)	Freight Traffic (M train-km)	Charges per train-km (€)
1997	155	155,6	1,00
1998	159	154,1	1,03
1999	163	154,8	1,05
2000	165	154,7	1,07
2001	167	144,3	1,16
2002	170	143,9	1,18
2003	156	130,4	1,20
2004	163	121,6	1,34
2005	159	105,7	1,50

Nevertheless, the linkage between charges and traffics remains unclear and probably low; it would be certainly misleading to see tariff evolution as the main reason for freight traffic decreases; expert views and interviews of operators tend to think that the impact of tariffs is rather low. First, the main effect of tariff evolution, that occurred when reservation fees were effectively implemented, was the suppression of "facultative" paths that were unused, thus this effect does not appear in traffic figures. Second, even though it increased globally, the charge level still represents a low share in operators' costs, especially for SNCF (around 8%), whereas the evolution of traffics showed important shocks that seem to be much more related to the changes in SNCF's freight strategy. Indeed, reorganization plans, railway strikes, the liberalization of fret services and economic globalisation have extensively confused the price signal and impacted the traffics at a much higher degree than could do the relatively small signal of infrastructure charge.

However, set now at higher levels, and in a more stable environment, infrastructure charges may play a stronger role in the future. At least, the steady increases, observed also in 2009 tariffs, may have an impact on operator's purchase strategy –choice of day period, train speed, routes. Unfortunately, we couldn't have any access to wagon loading rates, or to the relative use of off-peak periods, or to the distribution of train speed.

RFF considers that freight operators have enough willingness to pay for long-haul, high-speed traffic, which is generally the most profitable. Nevertheless, French operators are doubtful about RFF's ability to improve the quality of its freight path offer[2]. Discussions have been led recently[3] on 2010-2015 infrastructure charges tariffs; this could result in new increases, so as to obtain a better cost coverage ratio for RFF and, hopefully, improved infrastructure quality for freight trains.

As a conclusion, it has not been possible to show a precise impact of the increase and differentiation in RFF's freight tariffs. The lack of data from the two main sources, SNCF and RFF, was a major problem. Very important events on the operators' side and on the demand's side had a major effect, and data available was not precise enough to get effects sorted out. Nevertheless, it is highly plausible that RFF tariffs' evolution accompanied the other changes in the same direction, possibly accentuating the decreasing trends in traffic levels.

2.4 Freight Through Eurotunnel

Eurotunnel provides an interesting case, as rail freight through the tunnel has performed somewhat disappointingly over a number of years and the charges faced by freight operators have consistently

[2] Source: Interviews were conducted in March 2008 with SNCF and Euro Cargo Rail.
[3] Source: *le Journal du Dimanche*, March 23rd 2008.

been cited as a potential cause of this poor performance. After 14 years of service, the channel tunnel is far from operating at the level of capacity requested by the reports giving support to the tunnel alternative for a cross-channel fixed link. Having originally had a design capacity of approximately 10 million tonnes, freight traffic grew during the first 3 years of operation to three million tonnes in 1997. However, it then stagnated until 2000, before declining to just over one million tonnes in 2007.

Table 2-7 and Table 2-8 draw similar pictures for tunnel freight forecasts: a total traffic of about 30 million tonnes around 1993 and a total market share of about 35% for the tunnel, corresponding to about 10 Mt, with better market shares for rail wagons than for Le Shuttle.

Table 2-7 Historical Forecast for Freight: Total Cross-Channel vs. Channel Tunnel (Million Tonnes)

Freight forecasts		1969	1971	1980	1985	1990	2000
MoT (1963)	Via tunnel	2,6	2,9	4,0	4,5	-	-
C & L (1973)	Total demand	-	5,7	13,1	-	25,3	-
	Via tunnel	-	-	5,4	-	11,3	-
CTAG (1975)	Total demand	-	5,7	12,9	-	20,2	-
	Via tunnel	-	-	5,3	-	7,8	-
DoT (1982)	Total demand	-	-	15,9	-	27,3	37,2
	Via tunnel	-	-	-	-	8,6	11,1

Source: Chevroulet et al, 2007; Anguera, 2006

Table 2-8 CTG-FM Unitised Freight Forecasts –Total Demand & Market Share (Million Tonnes)

	Cross-Channel 1993	Tunnel freight 1993	Market share 1993	Tunnel freight 2003
Roll-on/roll-off freight	24,2	6,0	25	7,5
Containers and rail wagon	7,9	4,0	52	6,8
Total	32,1	10,0	31	14,3

Source: Chevroulet et al, 2007 ; Anguera, 2006[4]

However, actual traffic was much different, as shown in Table 2-9 and Table 2-10. The total freight tonnage was underestimated by most of the forecasts, and the traffic of through rail services remains very low compared to forecast and to freight shuttle. Freight shuttle service, in absolute terms, increased quite steadily ahead of what was forecast through to 2007. Nevertheless, forecasts for freight Shuttle's market share appeared to be not far from what occurred.

[4] "Roll-on/roll-off freight" includes "Le Shuttle Freight" and "Containers and rail wagon" includes "Through rail freight services".

Table 2-9 Actual Channel Tunnel FreightTonnages (Million Tonnes)

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Le Shuttle Freight	0,8	5,1	6,7	3,3	9,2	10,9	14,7	15,6	15,6	16,7
Through rail services	-	1,3	2,4	2,9	3,1	2,9	2,9	2,4	1,5	1,7
Total tunnel freight	0,8	6,4	9,1	6,2	12,3	13,8	17,7	18,8	17,1	18,4

Source: Chevroulet et al., 2007; Anguera, 2006

Table 2-10 Actual Channel Tunnel Freight Tonnage (Million Tonnes)

	2004	2005	2006	2007
Le Shuttle Freight	16,6	17	16,9	18,4
Through rail services	1,9	1,6	1,6	1,2
Total tunnel freight	18,5	18,6	18,5	19,6

Table 2-11 Cross-Channel Unitised Freight 1994-2003 (Million Tonnes)

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Channel tunnel	0,8	6,4	9,1	6,2	12,3	13,8	17,7	18,8	17,1	18,4
Port of Dover	15,1	14,0	13,9	20,8	19,8	21,7	21,0	23,0	24,1	23,2
Total cross-channel	15,9	20,4	23,0	27,1	32,1	35,5	38,7	41,1	41,2	41,6

Source: Chevroulet et al., 2007; Anguera, 2006

Eurotunnel's only forecast that proved to be more or less correct is the freight Shuttle's market share. This traffic obeys mainly to road logics, for which existing methods, data and tools were more appropriate for doing forecasts. A hypothesis we can make is that by the time forecasts were made, the methods and tools used were built using these road logics, inducing no anticipation of strong competitive reaction (a shipping line is very mobile, unlike roads; prices are not often a competitive tool in the road sector) and modelling the competitive situation as a network composed of minor (high cost) "road links" for the ferries, compared to a new (low cost) motorway for the Tunnel. Another hypothesis is that Eurotunnel had more incentive and tools to reach its forecasts of roll-on roll-off than of through trains. This last point leads us to the issue of infrastructure charges.

The situation of infrastructure charges for using Eurotunnel is a complex one, having involved 3 major components. Prior to the opening of the tunnel, a fifty-year agreement was formed between Eurotunnel and the two then state railways, British Rail and SNCF, that each be allocated half of the tunnel's capacity in return for the payment of infrastructure charges. In addition, the two railways agreed to pay a Minimum Usage Charge each year for using the tunnel, irrespective of how many trains actually used it. Thirdly, the two railways agreed to pay a fixed annual contribution to Eurotunnel's operating costs, amounting to approximately £6.5 m each.

The infrastructure charges were initially levied on a per tonne basis, based on a guide price of £10 per tonne and an overall volume of 10m tonnes. To that was added fixed charges for Eurotunnel and for essential facilities at either end of the tunnel, each of which should have added another £1 per tonne. In reality though, those fixed charges were divided by the number of trains, and, since there were not many trains, this ended up resulting in very high charges. The per tonne charges were differentiated between bulk and non-bulk traffic, though – apparently somewhat counter-intuitively – the charge for non-bulk was three times that for bulk traffic.

On rail privatisation in Britain, freight operations through the tunnel were sold to EWS, but it was agreed that government retain the responsibility for paying the infrastructure charges, the Minimum

Usage Charge and the operating cost contribution through until November 2006. As of 2006, the agreement was that the Minimum Usage Charge would cease and the payment of infrastructure charges and the operating cost contribution would transfer to EWS. Subsequently, EWS have agreed with the government that the operating cost contribution continue to be paid by the government, leaving EWS to pay the remaining infrastructure charges. On the French side, SNCF has, throughout the past 14 years, been responsible for all 3 charging components.

Following the cessation of the Minimum Usage charge and continued decline in rail freight traffic through the tunnel, discussion between the key stakeholders led to another set of revised charges being announced in autumn 2007. This set of charges, set out below, was issued as part of Eurotunnel's strategy for 'relaunching' Open Access cross-Channel rail freight. The charges are focused around a central average charge of 4.5k Euro (£3k) per train, irrespective of train-load. This central charge represents a significant reduction compared to the 2007 average charge of 8k Euro (£5,3k). Furthermore, the charges are differentiated according to speed and time of day. The central charge is based on a train passing through the tunnel at a speed of 120kph during a period of medium traffic density; lower charges are applicable for higher speeds and/or periods of lower traffic density, and vice-versa. Most intermodal/non-bulk traffic tends to travel at 120kph, whilst bulk traffic has tended to travel at slower speeds. At the same time, additional measures have been introduced to provide operators guarantees of equitable and efficient open access to the essential facilities at either end of the tunnel.

Table 2-12 Eurotunnel Infrastructure Charges, 2007-08

Train @ 120 km/h	Reservation fee per train single (£)	Access fee per train single (£)	Equivalent price per train single (based on 52 train single/year) (£)
Off-peak period	270	2430	2700
Intermediate period	300	2700	3000
Peak period	330	2970	3300

Train @ 100 km/h	Reservation fee per train single (£)	Access fee per train single (£)	Equivalent price per train single (based on 52 train single/year) (£)
Off-peak period	300	2700	3000

Maintenance periods	Reservation fee per train single (£)	Access fee per train single (£)	Equivalent price per train single (based on 52 train single/year) (£)
All trains @ 100 km/h	300	2700	3000

Source: Eurotunnel's Network Statement - 2008 Working Timetable

These new charges, and the relaunch strategy, appear to be having clear impacts on rail freight traffic. Firstly, EWS report that they have increased the speed of their bulk traffic so as to take advantage of the lower charge for this. This has been somewhat fortuitous, as the change occurred at a time when they happened to have the rolling stock available to enable this. Secondly, EWS have announced the commencement of two regular Channel Tunnel services. Thirdly, though on a more negative note, Freight Europe UK have announced withdrawal of services apparently in response to the new charges. Freight Europe UK have been providing a less than train-load service between continental Europe and the UK which was, whilst charges were on a per-tonne basis, viable. However, with the switch to per-train charges, their payments have increased as they have begun having to pay for empty or part-empty trains. It may be that this is a temporary problem, as they rationalise their service and arrive at a new level of service, although it may also be the case that such a rationalised level of service may no longer be sufficiently attractive to customers and that they find their service having to be rationalised further.

The main problem of the forecasts, as compared with the actual traffic, seems to rely on the nature of the market Eurotunnel could try to grasp. The reaction of ferries proved to be quite effective at cutting Eurotunnel from a good part of its expected market, among other means by concentrating and reinforcing offers for origin-destination trips remote from the Channel. The decline in competitiveness relative to road transport, as a result of the impact of the fixed costs of frontier infrastructure (including security constraints) proved to be further constraints on channel Tunnel rail freight growth.

Hence, the original charges were devised with no reference to the market, and the monopoly and state aid aspects of the market rendered them irrelevant as signals to the market. Since the removal of state aid, opening up of the market and establishment of the new charging regime, traffic appears, on the whole, to be responding positively, though it is too soon to say whether this is a sustained turn-around.

2.5 MODELLING REACTIONS IN THE BRITISH RAIL FREIGHT MARKET

The effect of changes in rail access charge regimes on rail and road traffic in Britain have been modelled using the Leeds Freight Transport Model (LEFT) (Johnson et al, 2007)). The LEFT model is essentially an aggregate mode split model for road and rail freight traffic in Britain, capable of forecasting changes in traffic for different commodities and modes following changes in transport costs. LEFT was initially constructed in 2002 and has been further developed over subsequent years, the current version being LEFT3. The model has no geography and uses Binary Logit models calibrated to existing data to perform mode split. Market size is determined using elasticities of tkm with respect to Generalised Cost and applying them with the mode split element stripped out. Disaggregation within LEFT3 is by the following dimensions:

1. The base data is split over 7 commodity groups consistent with the categories provided in the Department for Transport's Continuing Survey of Road Goods Transport (CSRGT) data, reported in Transport Statistics Great Britain (TSGB) (DfT, annual):
    a. Food, Drink and Agricultural Products;
    b. Coal, Coke and related items;
    c. Petroleum and Petroleum Products;
    d. Metals and Ores;
    e. Aggregates and Construction;
    f. Chemicals and Fertilisers;
    g. Other, including manufactures, miscellaneous, containerised, and international.
2. The base data by commodity is split over 9 distance bands, again consistent with those used by the CSRGT data. These are, 1-25 km, 25-50 km, 50-100 km, 100-150 km, 150-200 km, 200-300 km, 300-400 km, 400-500 km and Over 500 km. We have taken the midpoint of the 500+ distance band to be 550 km.
3. The base total market is split for each commodity and distance band according to whether traffic is favourable for rail operations, referred to as train-friendly (TF), or train-unfriendly (TU). For Bulks, TF traffic is that traffic we deem suitable for trainload movement from origin to destination. For Non-bulks (Food etc, and Miscellaneous), TF traffic is that to which we have assigned the need for collection and delivery (at most) at one end.

There are therefore 2*7*9 = 126 cells in LEFT3. Traffic can switch mode or distance band, disappear altogether or new traffic can be generated. Just two modes were modelled - road and rail. The data used was collected from a variety of sources. For road, the primary source has been the Continuing Survey of Road Goods Transport, as reported in TSGB. For rail we have used unpublished data from the SRA with gaps being filled by our own best estimates. Base data relates to the period 1998-2000. All monetary amounts are in 2000 prices. A base for 2010 was obtained by projecting current trends forward.

We are interested in looking at the responsiveness of rail traffic to different access regimes and pricing structures. We aim to see if, and to what extent, rail can replace some road traffic given the appropriate incentives. We determined the following six scenarios/policy tests to examine:

- Removing current track access charges- the idea here is to create the best possible scenario for rail freight and see how much growth there could be in these conditions, with the aim of mode shift from road to rail on environmental grounds.
- Halving current track access charges; again here the aim is to stimulate mode shift, whilst still recovering some track access revenues.
- Doubling current track access charges; here we see how rail traffic responds to a doubling of access charges across the board, with the aim of raising revenue from rail access charges.
- Quadrupling current track access charges; as for 3 but a larger increase.
- Introduce a structure of fixed and variable track access charges; punishing short distance rail traffic. This is approximated using distance bands, with doubled access charges for the shortest distance band, tapering down to current charges at the longest distance. The justification for this scenario is to remove some short distance rail traffic, for which rail may be not as well suited and for which there are fewer environmental benefits of mode shift
- A fixed and variable access charge stimulating long distance traffic. This is approximated by using differential charges over distance bands, with double access charges for the shortest distance, tapering down to ½ current charges at the longest distance. The justification here would be to stimulate a switch to rail from road only from that traffic for which rail is most suitable, namely long distance traffic, which will have a good environmental benefit and which is approximately revenue neutral.

Table 2-13 and Table 2-14 report the results for the 6 different scenarios compared to the 2010 Do Nothing. It can be seen that, in **Scenario 1 (Zero Access Charges)** Rail tonnes increase by 8.17 million (5.69%) and tkm increase by 2.13 billion (9.24%). Nearly half of the overall increased rail traffic is accounted for by an increase of 0.99 billion tkm in Ores & Metals. There is also a significant increase of 0.57 billion tkm in Others. The largest increases in rail's share of tkm are found in Chemicals (by 31.75%), Ores & Metals (by 21.6%) and Others (12.08%). The smallest absolute increases are in rails' Food, Drink & Agriculture and Petroleum tkm traffic. The smallest increases are in rail's share of tkm of Food, Drink & Agriculture, Petroleum and Coal & Coke.

In **Scenario 2 (Halved Access Charges)** Rail tonnes increase by 3.95 million (2.75%) and tkm by 1.02billion (4.43%). The magnitude of the effect of this scenario is approximately a half that of scenario 1, which is as expected. The increase of 0.48 billion tkm in Ores & Metals accounts for nearly half of the overall increased rail traffic. There is also a significant increase in Others and Construction traffic. The largest increases in rail's share of tkm are found in Chemicals (by 15.36%), Ores & Metals (by 10.60%) and Others (5.85%). The smallest absolute increases are in rails' Food, Drink & Agriculture , Petroleum, Coal & Coke and Chemicals tkm traffic. The smallest increases are in rail's tkm share of Food, Drink & Agriculture, Petroleum and Coal & Coke.

In **Scenario 3 (Doubled Access Charges),** Rail tonnes decrease by 7.16 million (4.99%) and tkm by 1.75billion (7.59%) overall. The drop of 0.83 billion tkm in Ores & Metals accounts for nearly half of the overall lost rail traffic. There is also a significant drop of 0.50 billion tkm in Others. The largest percentage reductions in rail shares of tkm are in Chemicals (by 27.54%), Ores & Metals (by 18.17%) and Others (by 10.59%). The smallest absolute falls are in rails' Food, Drink & Agriculture, Petroleum and Coal & Coke tkm. The smallest effects on rail's share of tkm are in Food, Drink & Agriculture, Petroleum and Coal & Coke.

In Scenario 4 (Quadrupled Access Charges), Rail tonnes decrease by 17.97 million (12.51%) and tkm by 4.29 (18.62%) overall. The drop of 1.88 billion tkm in Ores & Metals accounts for over one third of the overall lost rail traffic. There is also a significant drop of 1.33 billion tkm in Others and 0.38 billion tkm in Construction. The largest reductions in rail's share of tkm are in Chemicals (67.27%), Ores & Metals (41.12%) and Others (28.3%). The smallest absolute falls in rails' Food, Drink &

Agriculture and Petroleum tkm traffic. The smallest effects on rail's share of tkm are in Food, Drink & Agriculture, Petroleum and Coal & Coke.

In **Scenario 5 (Higher Short Distance Access Charges)** rail tonnes decrease by 4.28 million (2.98%), and tkm by 0.82 billion (3.54%). Compared to scenario 3, tonnes fall by proportionally more than tkm highlighting that the reduction in rail traffic is more concentrated in the shorter distances than in scenario 3. In absolute terms, the drop of 0.43 billion tkm in Ores & Metals accounts for more than half of the overall lost rail traffic. There is also a significant drop of 0.18 billion tkm in Others. The largest decreases in rail shares of tkm are in Chemicals (by 12.85%), Ores & Metals (by 9.41%) and Others (by 3.88%). The smallest absolute decreases in Food, Drink & Agriculture, Petroleum, Coal & Coke and Chemicals tkm traffic. The smallest decreases in rail's share of tkm are in Food, Drink & Agriculture, Coal & coke and Petroleum.

In **Scenario 6 (Higher Short Distance and Lower Long Distance Access Charges)**, rail tonnes decrease by 2.65 million (1.85%) and tkm decrease by 0.27 billion (1.16%), highlighting that much of the reduction in traffic is over the short distances. Interestingly there is little increase in Food, Drink & Agriculture tkm (0.06%) but decreases in all other commodities – very little of rail's traffic in this commodity is in the shorter distances. The largest absolute falls are found in Ores & Metals and Construction. The largest decreases in rail share of tkm are in Chemicals (by 5.15%), Ores & Metals (by 4.02%) and Construction (by 1.04%). The smallest reductions in rail's market share of tkm are found in Coal & Coke, Others and Petroleum.

Table 2-13 Tonnes Lifted by Commodity for Different Scenarios in 2010

Scenario	Mode	Tonnes lifted [millions]							
		Food, Drink, Ag	Coal & Coke	Petroleum	Ores & Metals	Construction	Chemicals	Others	TOTALS
Do nothing	Road	525.86	23.30	85.49	75.89	676.09	69.18	708.69	2164.50
	Rail	11.32	42.12	10.84	33.82	27.72	1.64	16.17	143.63
Scenario 1 Zero access charges	Road	525.83	23.20	85.38	73.19	675.88	68.77	708.34	2160.60
	% change from do nothing	*-0.01*	*-0.42*	*-0.12*	*-3.57*	*-0.03*	*-0.60*	*-0.05*	*-0.18*
	Rail	11.48	42.22	10.95	38.31	28.76	2.12	17.96	151.80
	% change from do nothing	*1.41*	*0.24*	*0.99*	*13.29*	*3.74*	*29.57*	*11.06*	*5.69*
Scenario 2 Halved Access Charges	Road	525.84	23.25	85.44	74.56	675.98	68.99	708.52	2162.58
	% change from do nothing	*0.00*	*-0.22*	*-0.06*	*-1.76*	*-0.02*	*-0.29*	*-0.02*	*-0.09*
	Rail	11.39	42.17	10.89	36.04	28.17	1.87	17.05	147.58
	% change from do nothing	*0.65*	*0.12*	*0.44*	*6.56*	*1.63*	*14.21*	*5.39*	*2.75*
Scenario 3 Doubled Access Charges	Road	525.89	23.43	85.56	78.32	676.33	69.53	709.00	2168.05
	% change from do nothing	*0.01*	*0.55*	*0.08*	*3.19*	*0.04*	*0.50*	*0.04*	*0.16*
	Rail	11.18	41.99	10.77	29.70	27.02	1.23	14.57	136.46
	% change from do nothing	*-1.19*	*-0.30*	*-0.61*	*-12.19*	*-2.52*	*-24.93*	*-9.94*	*-4.99*
Scenario 4 Quadrupled Access Charges	Road	525.97	23.69	85.65	81.75	676.96	70.01	709.53	2173.57
	% change from do nothing	*0.02*	*1.69*	*0.19*	*7.72*	*0.13*	*1.20*	*0.12*	*0.42*
	Rail	10.89	41.73	10.70	23.88	25.99	0.66	11.82	125.66
	% change from do nothing	*-3.82*	*-0.93*	*-1.32*	*-29.39*	*-6.22*	*-59.94*	*-26.91*	*-12.51*
Scenario 5 Higher Short Distance Access Charges	Road	525.88	23.37	85.54	77.46	676.24	69.37	708.84	2166.70
	% change from do nothing	*0.00*	*0.32*	*0.06*	*2.07*	*0.02*	*0.27*	*0.02*	*0.10*
	Rail	11.23	42.05	10.79	31.16	27.26	1.42	15.44	139.35
	% change from do nothing	*-0.79*	*-0.18*	*-0.41*	*-7.85*	*-1.66*	*-13.46*	*-4.54*	*-2.98*
Scenario 6 Higher Short/ Lower Long Distance Charges	Road	525.88	23.35	85.52	76.98	676.20	69.29	708.75	2165.96
	% change from do nothing	*0.00*	*0.20*	*0.04*	*1.43*	*0.02*	*0.15*	*0.01*	*0.07*
	Rail	11.26	42.07	10.81	32.00	27.40	1.52	15.91	140.97
	% change from do nothing	*-0.51*	*-0.11*	*-0.30*	*-5.38*	*-1.14*	*-7.41*	*-1.61*	*-1.85*

Table 2-14 Tonne-Kilometres by Commodity for Different Scenarios in 2010

Scenario	Mode	Tonne kms [Billions]							
		Food, Drink, Ag	Coal & Coke	Petroleum	Ores & Metals	Construction	Chemicals	Others	TOTALS
Do nothing	Road	63.33	2.31	8.29	8.53	35.91	8.84	73.09	200.30
	Rail	2.17	5.13	2.13	4.57	3.94	0.40	4.69	23.04
Scenario 1 Zero access charges	Road	63.29	2.30	8.26	7.59	35.68	8.71	72.55	198.39
	% change from do nothing	*-0.06*	*-0.62*	*-0.27*	*-11.05*	*-0.62*	*-1.43*	*-0.74*	*-0.95*
	Rail	2.21	5.24	2.17	5.56	4.19	0.53	5.26	25.17
	% change from do nothing	*1.96*	*2.10*	*2.03*	*21.60*	*6.46*	*31.75*	*12.08*	*9.24*
Scenario 2 Halved Access Charges	Road	63.32	2.31	8.28	8.07	35.81	8.78	72.83	199.38
	% change from do nothing	*-0.03*	*-0.32*	*-0.12*	*-5.43*	*-0.26*	*-0.69*	*-0.36*	*-0.46*
	Rail	2.19	5.18	2.15	5.06	4.05	0.46	4.97	24.06
	% change from do nothing	*0.82*	*1.02*	*0.95*	*10.60*	*2.75*	*15.36*	*5.85*	*4.43*
Scenario 3 Doubled Access Charges	Road	63.36	2.33	8.30	9.33	36.02	8.95	73.56	201.85
	% change from do nothing	*0.04*	*0.61*	*0.18*	*9.42*	*0.32*	*1.24*	*0.65*	*0.78*
	Rail	2.15	5.04	2.10	3.74	3.78	0.29	4.20	21.29
	% change from do nothing	*-1.20*	*-1.85*	*-1.61*	*-18.17*	*-3.92*	*-27.54*	*-10.59*	*-7.59*
Scenario 4 Quadrupled Access Charges	Road	63.40	2.36	8.32	10.34	36.19	9.11	74.35	204.07
	% change from do nothing	*0.11*	*2.09*	*0.38*	*21.26*	*0.78*	*3.02*	*1.73*	*1.88*
	Rail	2.10	4.87	2.04	2.69	3.55	0.13	3.36	18.75
	% change from do nothing	*-3.41*	*-5.12*	*-4.13*	*-41.12*	*-9.76*	*-67.27*	*-28.30*	*-18.62*
Scenario 5 Higher Short Distance Access Charges	Road	63.34	2.32	8.30	8.94	35.97	8.89	73.26	201.03
	% change from do nothing	*0.02*	*0.40*	*0.11*	*4.84*	*0.19*	*0.58*	*0.23*	*0.36*
	Rail	2.16	5.09	2.11	4.14	3.85	0.35	4.51	22.22
	% change from do nothing	*-0.50*	*-0.72*	*-0.89*	*-9.41*	*-2.17*	*-12.85*	*-3.88*	*-3.54*
Scenario 6 Higher Short/ Lower Long Distance Charges	Road	63.33	2.32	8.29	8.70	35.94	8.86	73.09	200.54
	% change from do nothing	*0.00*	*0.29*	*0.07*	*2.01*	*0.09*	*0.23*	*0.00*	*0.12*
	Rail	2.17	5.12	2.12	4.39	3.90	0.38	4.69	22.77
	% change from do nothing	*0.06*	*-0.12*	*-0.50*	*-4.02*	*-1.04*	*-5.15*	*-0.15*	*-1.16*

Overall, changes in rail freight traffic are driven primarily by the shifts in Ores & Metals traffic, (as this accounts for 19.8% of Rail's overall tkm traffic), and also Others (accounting for 20.4%). Although Coal & Coke accounts for 22.3% of rail's tkm traffic, there is little movement in tkm as its market share stays relatively static due to the level of captivity and the favourability of rail over longer distances. There are relatively significant changes in Construction, which accounts for 17.1% of rail's tkm traffic. Whilst there are large shifts in the market shares of Chemicals, these represent very small absolute changes in tkm.

In summary, by using LEFT, we have been able to explore the potential impacts of variations in infrastructure charging in isolation from any other changes that might impact on the rail freight market. We have found that by removing access charges, rail tonne kms increase by 9%, reducing road traffic by almost 2 billion tkm, just 1%. This highlights an underlying lack of competitiveness of rail in key freight markets such as Food Drink and Agriculture and Construction, because of high captivity to road transport, given the short distances involved and the lack of suitable rail infrastructure. We have examined the sensitivity of the rail market to levels of access charges and found that rail is slightly less sensitive to access charge increases than it is to equivalent decreases. If we introduce different structures of access charging over distance bands, approximating a fixed and variable charging regime, we have shown how we can incentivise rail traffic over the longer distances where rail is more competitive and environmentally more beneficial.

2.6 SIMULATION MODELLING

A further line of analysis has been pursued using a method referred to as "sensible simulation", which is described as having the following features:

- First, it involves a simple network: one or a few origin-destinations, one or two modes serving these relations.
- Second, the nature of competition between the operators is typified according to classical and straightforward structures: monopoly or Bertrand duopoly competition[5].
- Third, the demand function is either a linear one or a logit one; constant elasticity demand may also be used when the rail competitor does not have a strategic pricing behaviour – for example, use of personal vehicle.
- Fourth, the cost functions of the operators are linear.
- Fifth, the parameters of the cost and demand functions are not calibrated on a specific real situation, but set up in order to reproduce typical situations such as: long distance trips competition between air and rail; short distance competition between road and rail, competition between two rail operators. The values of the parameters are set in relation to the common knowledge of the specialists of the field; elasticities are drawn from the results of current traffic models, costs are drawn from various analyses of the cost structure of operators.
- Other parameters may be introduced such as the cost of public funds or external costs.

The fact that the network and the modelling principles are simple and do not involve much data allows to make a lot of simulations regarding the shape of the demand function, the values of the parameters, the behaviour of the operators, and therefore to by-pass the scarcity of reliable data through exploration of the sensitivity of the results to the parameters.

It must be stated that simulation results do not provide evidences nor general truths, but only indicative elements derived from the data sets and models used. We have tried to test the robustness of our observations through several means, and to get ideas of the magnitude of the sensitivity of the results. For simplicity, the tables given do not precise the values of parameters that stay unchanged for the comparison.

5 Bertrand Competition is a widely acknowledged model of price competition between Duopoly firms which results in each charging a price equal to marginal cost. It depends on a number of assumptions, but generally refers to firms who compete on price and publish non-negotiable sets of prices.

Simulations provide several results. Some of them are confirmation of already well known results. Others pertain to the sensitivity of the results to calibration parameters such as the shape of the demand function or costs and prices. A last series gives indications that may be interesting for infrastructure charging policy and especially indications concerning the degree of interest of introducing some differentiation. The following paragraphs set out the general results of the simulations. In fact most of the results come from passenger data sets, though freight specific results are subsequently elaborated.

Infrastructure Charges can be differentiated in many ways. Simulations have been designed to explore some of them. A first set of simulations relates to the averaging of infrastructure charges according to several links: does it make sense, what is the loss in welfare, what are the impacts on the operators' profits? The differentiation criteria analysed individually are operator's marginal costs, elasticities and marginal infrastructure costs; a simulation of infrastructure charge differentiation for several "real" links concludes this first set. A second set of simulations relates to the drivers of the infrastructure charges: is it better to charge the trains, as it is done in most cases nowadays, or the occupancy of trains? Of course it is better to charge both, but what is the gain to do so, is it sufficient to overcome the practical complications it implies? Finally, the case of competing rail operators is treated.

Considering the question of how much infrastructure charges should be different when operators' costs are different, Table 2-15 below shows the impact of differences in marginal operators' costs: the effect of an increase of operator's marginal cost is to decrease the optimal tariff. The decrease seems to be similar in situation of duopoly than in situation of monopoly, but it could well be lower in other cases since, in a duopoly, the competitor exerts an effect which limits the market power of the operator. In any case it appears that the positive but rather low effect on welfare implies important effects because of the distributive effects between the agents: infrastructure manager, operators, and consumers. This point is a general conclusion of all the simulations.

In the following tables, illustrating the simulation results:

- The capital letters A, B, C…… correspond to various link cases from the simulation data set;
- IC represents Infrastructure Charge (sometimes also designated by a T);
- IM represents Infrastructure Manager;
- RO represents Rail Operator;
- p1 represents the RO's price;
- p2 represents the competitors' price;
- more generally letters suffixed by the number 1 relate to the RO and suffixed by the number 2 relate to its competitor.
- Qi represent the RO's and the competitors' traffic (measured as shares of the total traffic);
- ci represent their marginal costs (not including IC);
- si represents the parameters characterising the exerted market power, defined by (pi-ci)/pi = (si/eii) where eii are the price elasticities of each competitor.

Table 2-15 Effect of Differences in Operators' Marginal Cost

	Market Structure	Cost of Operator 1	Prices of Operator 1	Operator 2	Optimal Charge
C	Monopoly	16.2	50.3		4.3
		19.5	52.9		4.0
E	Duopoly	24.0	64.4	90.3	20.4
		28.8	67.9	90.8	19.9

Note: for the understanding of this table, it must be noted that the market of the C relation is a monopoly, (just one operator,) while market of the E relation is duopoly (two operators).

Considering the question of how much charges should differ when demand elasticities are different, Table 2-16 and Table 2-17 show that the optimal tariff is rather sensitive to the demand characteristics.

Table 2-16 Effect of Differences in Elasticities in the Case of Monopoly

	Elasticities e11	Prices p1	p2	IC
B	-1.0	46.4	94.9	-9.2
B	-1.5	36.9	94.9	-5.9

In the case of a duopoly the demand function of which is logit, assessing the effect of elasticity is a bit difficult as elasticities depend on the value of the parameter « *h* » of the demand function that represents the weight given to the price: the higher *h*, the higher the elasticities, everything else being equal. The test has been to increase *h* by 10%; the results are shown in the following table:

Table 2-17 Effect of Differences in Elasticities in the Case of Duopoly

Link	H	p1	p2	T[6]
F	0.042	52.99	73.57	7.32
F	0.047	50.70	72.80	7.71

The optimal charge is sensitive to the elasticities: the higher the elasticities, the higher the charge. This point is understandable: when elasticities are high, the monopoly power of the operators is lower and the charge can be increased in a due proportion.

From these results two conclusions can be drawn:

- First, it is important to have a good knowledge of elasticities, as the optimal tariff is highly varying with them. Unfortunately there is considerable uncertainty regarding these elasticities, so efforts should be made to improve our knowledge in this field.
- Second, it is wise to differentiate the infrastructure tariffs according to the characteristics of the demand, and to carefully design this differentiation as it appears to depend on the market structure.

Table 2-18 shows the effect of differences in infrastructure costs. It relates to situations where the same link bears several types of traffic, for instance freight traffic and passenger traffic, or passenger trains with different number of carriages or different types of carriages (for instance double and simple deck), which impose different degrees of damage to the track. Wrong price signals come from an

[6] Where T represents the optimal infrastructure charge level.

abusive assimilation of different infrastructure charges, but the impact seems to be rather minor when compared with the impact of other elements such as cost of public funds or elasticity level.

Table 2-18 Effects of Changes in Infrastructure Costs

	Infrastructure Costs ofoperator 1	Parameters		Prices		Optimal		
		s1	s2	p1	p2	IC	Traffic mode1	Traffic mode 2
A	2.06	0.29		40.25		10.18	0.18	0.29
A	1.03	0.29		39.11		9.03	0.19	0.29
D	3.44	0.42	0.18	42.44	61.18	9.14	0.30	0.30
D	1.72	0.42	0.18	41.13	61.14	7.59	0.31	0.30

It appears that an increase in infrastructure costs is passed on the tariffs by roughly the amount of its monetary value.

Table 2-19 shows that averaging the optimal infrastructure charges of two or three links does not induce a large loss in welfare if the differentiated charges are not too far from one another. However, if they are quite different from each other, the loss may be important and the effect can be to exclude profitable services from the market. This point is a caveat for the temptation to use a unique infrastructure charge over too large a set of links whenever the characteristics are different in terms of both costs and demand.

Table 2-19 Effect of Infrastructure Charge Averaging

	s1	s2	p1	p2	T	Length of the link in km	Q1	Q2	Welfare
A	1.00	_	51.68	_	-10.11	200	0.14	_	27.82
E	1.00	1.00	87.41	128.80	13.45	900	0.36	0.35	-15.76
F	1.00	1.00	60.27	101.83	8.33	700	0.31	0.33	-6.83
									5.23
A	1.00	_	62.92	p21	2.56	200	0.11	Q21	27.49
E	1.00	1.00	86.14	128.56	11.52	900	0.37	0.35	-15.78
F	1.00	1.00	60.71	101.90	8.96	700	0.31	0.34	-6.84
									4.88

Note: in this table, the first group of rows relates to fully differentiated tariffs; the second group of rows relates to a uniform tariff per km

Simulations made for sub-markets that were all over-charged as compared to optimal levels, as well as for sub-markets that were all under-charged, showed the same results: low impact of differentiation on welfare, but possibly high impact on revenue distribution. Still, the impact of charge differentiation on welfare may become more important when the envelope of actual infrastructure charges intersects the envelope of optimal infrastructure charges. This can be the case when demand or supply parameters are broadly dispersed; for instance, when both freight and passenger markets are considered.

Up to now, the infrastructure charge driver has been assumed to be the users (number of passengers or of tons). This is at odds with the most frequent charging system, for which the drivers are the trains. Both are similar if the occupancy rate is constant, but this assumption, though sensible, is not always fulfilled. We relax it by introducing a two-drivers charging system, based both on the number of users and on the number of trains. In that case two decision variables are in the hand of the operator: the number of trains and the occupancy rate of each of them.

The analysis of such a charging system is more complicated. Let us outline it in the case of a monopoly and with simple assumptions concerning demand. The demand is assumed to be evenly spread over time. Both the infrastructure manager and the operator's cost functions have two drivers: the number of users and the number of trains. The optimal charges can be expressed when the cost of public funds (CPF) is zero, and the values are as follows:

$$p_s = b_s$$

$$p_u = b_u + \frac{\lambda}{1+\lambda}\frac{Q_0}{(\frac{\partial Q}{\partial Cg})_0}$$

Where :

- *ps* is the infrastructure charge per train;
- *pu* is the infrastructure charge per user;
- *bs* is the infrastructure cost per train;
- *bu* is the infrastructure cost per user;
- *Q0* is the optimal traffic level;
- *Cg* is the generalised transport cost: $Cg=\pi+\theta/N$;
- π is the transport price fixed by the RO;
- θ is the sensitivity of the user to the frequency of the trains;
- *N* is the optimal number of trains per unit of time;
- λ is the CPF common to the RO and to the IM.

N and *Q0* are determined by the two relations:

$$\frac{\theta Q_0}{N_0^2} = b_s + c_s$$

$$\pi_0 + \frac{\lambda}{1+\lambda}\frac{Q_0}{(\frac{\partial Q}{\partial Cg})_0} = b_u + c_u$$

These relations show that in some sense *N* is commanded by *ps* and *Q* is commanded by *pu*. The existence of two command variables allows improving the welfare.

This point is shown by the numerical simulations, which furthermore allow setting different CPF for the infrastructure manager and for the RO. In the following table it appears that the existence of two part infrastructure charges highly improves the welfare. It seems that the improvement is dependent on the CPF of the infrastructure manager: it is high when the CPF is low (but to the expense of a large deficit of the infrastructure manager) and low in the reverse situation. And we must also note that we have not considered congestion costs here, whereas a two part infrastructure charge can be expected to reduce the incentive the operator has for increasing the occupancy of its trains and optimising the use of the network. In order to explore more in depth this interesting question, we would need data on congestion costs, production optimisation processes and on the structure of passengers' preferences.

This question would indeed deserve further research, for the moment a provisional result would be that, even though introducing a two-part infrastructure charge that takes into account the number of passengers in the train seems to be welfare improving at first sight, it does not change the welfare much if the CPF of the infrastructure manager is high and it could be welfare reducing if congestion concerns are at stake.

Table 2-20 Effect of a Two-Part Infrastructure Charge[7]

IM's CPF	RO's CPF	RO's price	GC for the user	ps	pu	Number of trains	Occupancy rate	Welfare Gain of a two part IC	Total IC per train	RO's Profit per train
1	1	13.32	15.68	38.28	0.00	64	59		38	408
1.3	1	12.98	16.02	120.65	0.00	49	73		121	432
1.6	1	12.57	16.43	239.84	0.00	39	88		240	416
1	1	5.00	7.04	100.00	-16.96	73	98	14.129	-1.559	1557
1.3	1	11.51	14.57	160.00	-2.91	49	85	934	-88	627
1.6	1	12.90	16.71	219.99	0.61	39	84	61	271	378

The situation here is a duopoly on rail: both operators run rail services, and they are competing in a Bertrand mode. Their market shares and quality characteristics are different. Is it good to differentiate their tariffs? The evidence obtained from our data set is that generally differentiation between rail operators induces a very small extra welfare, as shown in the following table, where the first row relates to differentiated IC, while the second relates to non differentiated IC:

Table 2-21 Effect of Tariff Differentiation in a Situation of Competing Rail Operators

CPF IM	CPF operator	s1	s2	p1	p2	IC Operator 1	IC operator 2	Q1	Q2	W
1.5	1.0	0.35	0.12	66.7	55.7	30.2	33.8	0.4	0.4	-10.8
1.5	1.0	0.35	0.12	68.2	54.2	32.1	32.1	0.4	0.4	-10.9

But in some cases when one of the operators does not bring much welfare (either as a result of its poor quality of service or its cost inefficiency), a differentiated infrastructure charge allows it to be excluded from the market, while a uniform charge allows this inefficient operator to remain in the market, at the price of a loss of welfare. Still, even though being somewhat inefficient, an operator may play a strategic role for keeping an incentive for the main operator to behave reasonably.

We now turn to consider the freight-specific findings of the above. First of all, freight markets are not as atomistic as passenger markets. Indeed the majority of the traffic comes from concentrated traffic generators such as steel plants. This means that their logistic decisions will not be as “spot reactions” as the individual reactions of a passenger. Typically, logistic organisations need 6 months to one year or more to get changed, especially when it comes to changing the main transport mode.

Also, the traffic level will be highly dependent on the dynamics of production organisation and distribution organisation, and on the import-export international trends of each specific production or consumption sector. The reaction of such concentrated markets is also likely to be more of an “all or nothing” reaction, contrarily to passenger traffic. Passenger traffic, due to the statistical distribution of atomistic decision-makers, ends up adapting more finely in terms of traffic level to a change, say, in the rail price level. Thus, a more proper use of elasticities can be made for passenger than for freight, driving forces behind traffic evolutions are more external in the freight markets, and differences between short-term reactions and mid-term reactions are likely to be more pronounced for freight markets.

[7] Where CPF = cost of public funds; ps = fixed part of the tariff; pu = unit price for the variable part of the tariff.

The range of variation of operating costs, and of infrastructure costs, may be high for the freight markets: train composition, train weight, transit time, auxiliary transport services, may be highly differentiated and relate to ad-hoc contracts between the rail operator and each of its big clients.
The competition conditions with road transport are stringent, but from the modelling point of view, it may be considered to be simpler, since the road competitor can be represented as having no strategic pricing attitude, its price being very close to its marginal cost that is not influenced by rail transport considerations. The rail-road market would have deserved more developments, since here the competition conditions are different: the road carrier may be a client of the rail operator and therefore strategic considerations may re-appear here.

In some freight markets, the relative market share of rail may be quite high, which is rarely the case for passenger traffic, except perhaps for some high speed lines. But the limitation of the market power comes from the economic consequences of the rail transport bill for the final cost of production or distribution of the products transported. Since competition has toughened a lot and occurs at an international level, all costs are very constrained and higher rail prices may well result in disappearance of the freight traffic concerned rather than partial reductions of their traffic level.

As concerns the simulation results, general observations made above are valid for freight, with the limitations considered above. A specific difficulty is that we had even more difficulties in getting information on marginal costs, prices, quantities, since they result from specific contracts rather than open public tariffs and offers.

Still, we tried to model some differentiated markets within the global freight market. In these simulations, we observed that the envelope of actual infrastructure charges could more easily intersect the envelope of optimal charges of the differentiated markets. This gives more room, perhaps, for IC differentiation within freight markets, since adjusting a common infrastructure charge level would give much less gain than differentiating infrastructure charge levels among the markets. This may contrast with the observations made for passenger markets, where optimal infrastructure charges may often be well below actual charges (at least, when the cost of public funds is not too high). Still, the relative position of actual versus optimal infrastructure charges may differ from country to country, for instance. Indeed, some countries do have high charges for freight and low charges for passenger, depending on history, relative importance of both markets, and public policies.

Table 2-22 An Example of the Intersection of Actual Infrastructure Charges' Envelope and Optimal Infrastructure Charge's Envelope

	IC	IM revenue	RO revenue	Consumer surplus	Externalities	Welfare
Optimal IC market 1	6.84	3.0	1.7	20.0	-2.2	23.5
Optimal IC market 2	2.47	-0.01	0.19	13.58	-4.28	9.49
Actual IC market 1	1.05	-1.0	2.5	23.8	-2.2	22.9
Actual IC market 2	3	0.1	0.2	13.5	-4.3	9.5

3 REACTIONS IN THE PASSENGER MARKET

3.1 INTRODUCTION

This chapter concentrates on reactions in the rail passenger market. This has included some assessment of the effect of infrastructure charges on passenger train operators as well as consideration of the effect of passenger fares on rail passengers.

In general, reactions to infrastructure charges in the passenger market have been much more difficult to analyse, as the presence of greater government intervention and subsidy tend to dampen or even entirely remove any incentives for train operators to react. The ‘sensible simulation’ exercise, referred to in section 2.6 above, also included consideration of the passenger market, though the findings were somewhat more tentative. The description of what was undertaken is set out in section 2.6, so we do not repeat that here. Within passenger markets, we have to distinguish at least between high speed, long distance services, and local services. The main modal competitor for high speed can be considered to be road for distances below 500 km and air for longer services. A great difficulty relates to the use of yield management techniques by rail operator that completely blur the picture of the actual prices and, also, make the assumptions on demand more fragile. Indeed, we should have considered sub-markets corresponding to yield management categories, but it was not possible here, would it be only for the reason of lack of data. Perhaps the logit formulation may be considered as being more adapted to this kind of situation.

For local services, since the great majority of them are operated under contracts with public local authorities, the model adopted does not represent the reality of interactions. Indeed, since in these contracts, infrastructure charges are fully reimbursed to the operator (and sometimes reimbursed by the State to the local authority), the logics of reaction to infrastructure charge level and to infrastructure charge differentiation are very specific and quite different from what we modelled here. It can even be considered that in such a situation, there is no reaction at all to charge level and differentiation.

The final interest of infrastructure charge differentiation seems to be more debatable in the case of passenger traffic than for freight. Higher differentiation would be desirable when sub-markets are quite differentiated as regards the main variables: for example, elasticities, or costs of public funds. This differentiation of the characteristics of passenger sub-markets can be found, whether between services - high speed, classical long distance services and local services -, or within passenger yield management categories. But for the first kind of differentiation, it corresponds roughly to the differentiation between physical lines that usually already exist (for example, high speed tracks have different charges than classical tracks and local high traffic tracks). And for the second kind of differentiation, we do not have access to the necessary data, and it would also lead to making more complex the question of two-part tariffs (passengers that pay very different prices due to yield management do still travel in the same train and sit close to each other, therefore infrastructure charge differentiation should take into account not only the number of passengers in the train, but also the number in each passenger category…).

Nevertheless, we have been able to undertake some interesting analysis of regional charge differentiation in Germany, and this is set out in section 3.2. Section 3.3 then considers passenger reactions to more or less complex fares structures. Section 3.4 then considers passenger reactions to fares levels, firstly by way of a review of available elasticity estimates and then with specific focus on the German passenger rail market.

3.2 REGIONAL FACTORS IN GERMANY

One main element within the track access charging system in Germany are the so called regional factors. This refers to a multiplicative surcharge[8] for certain parts of the network (a priori defined).

8 For instance, a regional factor with the value of 1.2 means that the total charge lies 20 percent above the same charge for the same train in another network part which has a regional factor of 1.0.

Therefore regional factors can also be seen as a regional differentiation element and we have sought to assess the effects of the regional factors. DB Netz, the German infrastructure manager, argues in favour of the regional factors on the basis that it is impossible to cover operating costs in particular regions due to the low demand in these parts of the network. However, DB Netz considers the possibility to negotiate the value of the regional factor in the case that the operators or public transport authorities purchase higher amounts of service. The regional factors are imposed in very low frequented parts of the network and therefore they concern public transport services in the short haul (up to 50 km).

Due to the regional nature of this differentiation element, it is necessary to start with a brief description of the regionalisation of urban passenger services that comprised part of the reform of Germany's railway system. Railway transport services are purchased from regional passenger transport authorities. These authorities on their part define the service and award it to the operators. The required money is transferred from the federal government to the states and subsequently to the regional urban transport organisations. Within the restructuring process of the country's railways it was scheduled that the level of the grants[9] could be flexible in order to maintain the travel timetables of the 1993/1994 period. Since 2003 the amount has increased by 1.5 percent per year. However, due to budgetary deficits the government has imposed a slight decrease (see Table 3-1) since 2006.

Table 3-1 Grants for the Urban Transport Services

Year	Regionalisation funds in Billions of €
1996	4.45
1997	6.14
1998	6.32
1999	6.31
2000	6.52
2001	6.85
2002	6.75
2003	6.85
2004	6.95
2005	7.05
2006	7.05
2007	6.71

Source: Aberle, (2003), and RegG.

For the whole period of time until 2005, the regionalisation grants have increased steadily. For the urban transport authorities as well as for the operators this meant that financing of urban transport services was without any risks. The urban transport authorities purchased a well defined transport service. Therefore there was less room for reactions. The decrease of funds however within the last two years (and apparently in the following years) will definitely drive urban transport authorities to optimise their services. In this case there are several reactions expected, concerning timetables, or even whole routes.

Hence, regional transport authorities are purchasing well defined services, regarding the following:

- Time of the service;
- Frequency;
- Train size.

[9] Among scientists exist controversial opinions, whether these amounts are subsidies or not.

As a result, it is impossible for the operators to react in an economical sense, since they have no risk to bear in an environment where services are defined to the smallest detail by the regulatory authority. Our analysis has, therefore, concentrated on the regional public transport authorities.

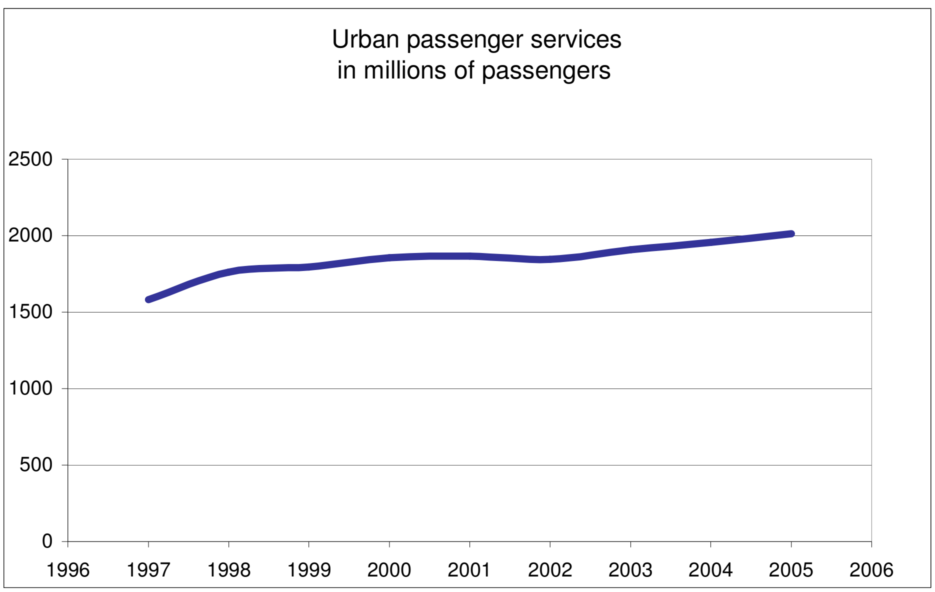
In the previous phase of work, we interviewed officials from VVO (Verkehrsverbund Oberelbe), the regional authority for the Dresden region. Within VVO there are 15 urban transport services suppliers operating. However, the most important of them are DVB (Dresdner Verkehrsbetriebe, providing services for the city of Dresden), DB Regio (providing railway services for the wider area around Dresden) and RVD (Regional Verkehr Dresden, providing bus services in the wider area around Dresden).

VVO indicated that, without the regional factors, many more transport services would be affordable. The possible effects recognized by VVO were the following:

1. Changes in timetables. VVO halved the services between Meissen and Nossen from 2 to one train per hour;
2. Use of alternative services. VVO introduced new rapid transit lines for the City of Dresden;
3. Partial or total integration of the additional costs in the fares.

Additionally we refer to the theoretical possibility of using another mode such as busses (although this is not a common practice in Germany).

In general, the urban transport railway market is a booming market in Germany. Figure 3-1 shows the development of the market in the last years.



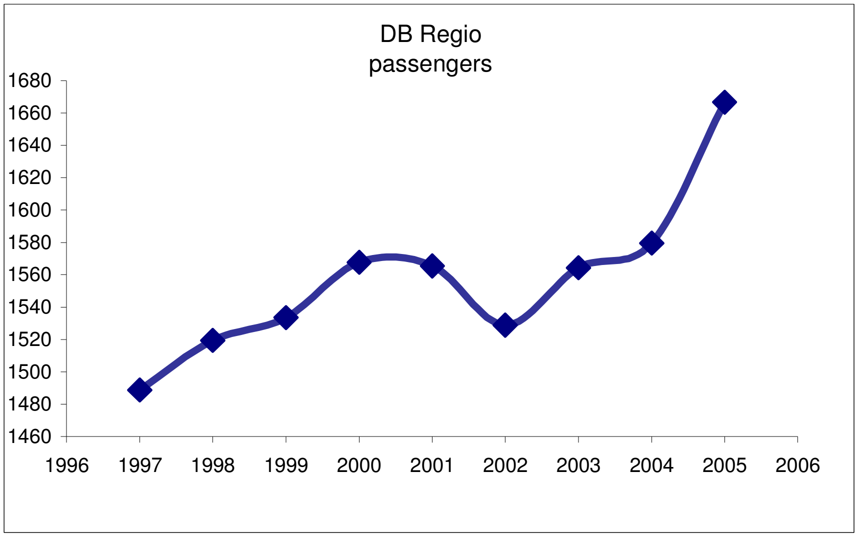
Source: authors own calculations based on DB annual reports

Figure 3-1 Urban Transport in Germany in Million Passengers

There are several drivers for this development. However, the main reasons are:

- The subsidizing scheme of urban transport,
- The introduction of competition,
- Urbanisation tendencies,
- Other factors such as higher fuel prices etc.

DB Regio, as the main supplier of urban rail services, has seen itself in the past trying to defend its prior position. Therefore output figures for DB Regio have not been followed with the general development (see Figure 3-2).



Source: DB annual reports

Figure 3-2 DB Regio Passengers

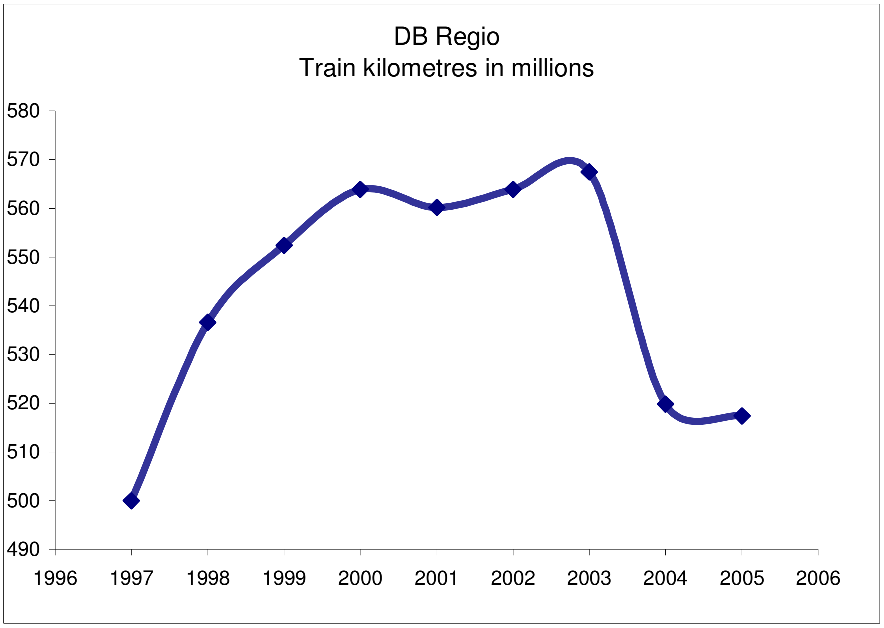
This however, may not be an expression of weakness or inefficiency but a calculated strategy. Carstensen (Carstensen, 2007) states that DB Regio deliberately withdraws services from such regions, which, due to eventual subsidy reductions, may be prone to the risk to cancel services in the future.

Figure 3-3 shows the train kilometres purchased by DB Regio. This explains to a certain point the general development by DB Netz. The decline after 2003 is mainly on the one hand due to a general market decline for that year and on the other hand the increased competitive tendering by the urban transport authorities. Therefore DB Regio competitors managed to achieve a considerable growth (Figure 3-4). However, although in urban transport infrastructure costs are fully covered through the regional authorities, DB competitors complain that access charges in the urban transport sector are too high. As reasons for this DB competitors give the following:

- Protection of DB Regio from competition;
- Shift of financial burden from long distance passenger services to urban transport.

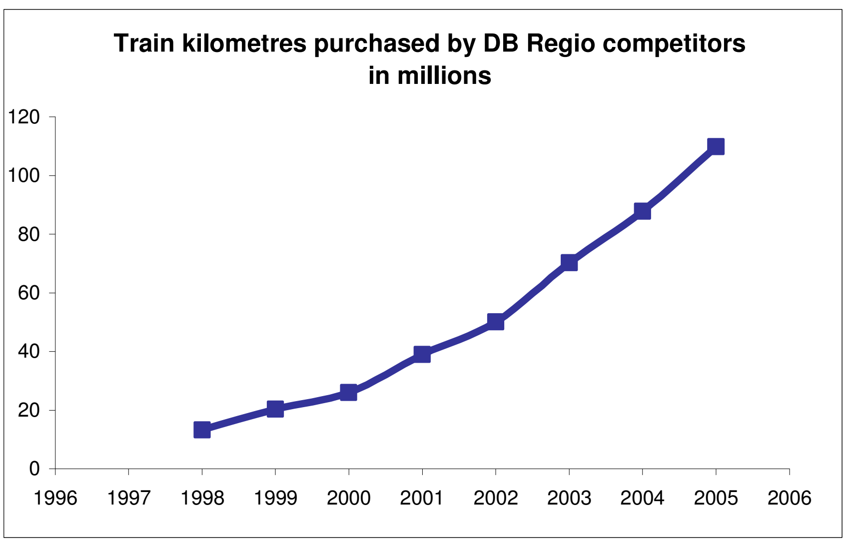
Carstensen (Carstensen, 2007) remarks that the cost shares of infrastructure in Germany (30-60 percent) are extraordinarily high. Therefore, in the case of marginal cost pricing (e.g. Denmark) private operators would be in a position to supply 40 – 50 percent of all urban transport routes profitably. For that reason the adequate charging level for private operators is around 60-70 Ct per train kilometre.

Urban transport operators regard access price differentiation predominantly as positive as long as costs are allocated fairly. For instance there should be a considerably higher charge for high speed tracks, since high speed trains have higher technological needs than conventional trains. Likewise peak load differentiation elements are accepted as long as peak load pricing is connected with price reductions for night services.



Source: DB annual reports

Figure 3-3 Train Kilometres Purchased by DB Regio

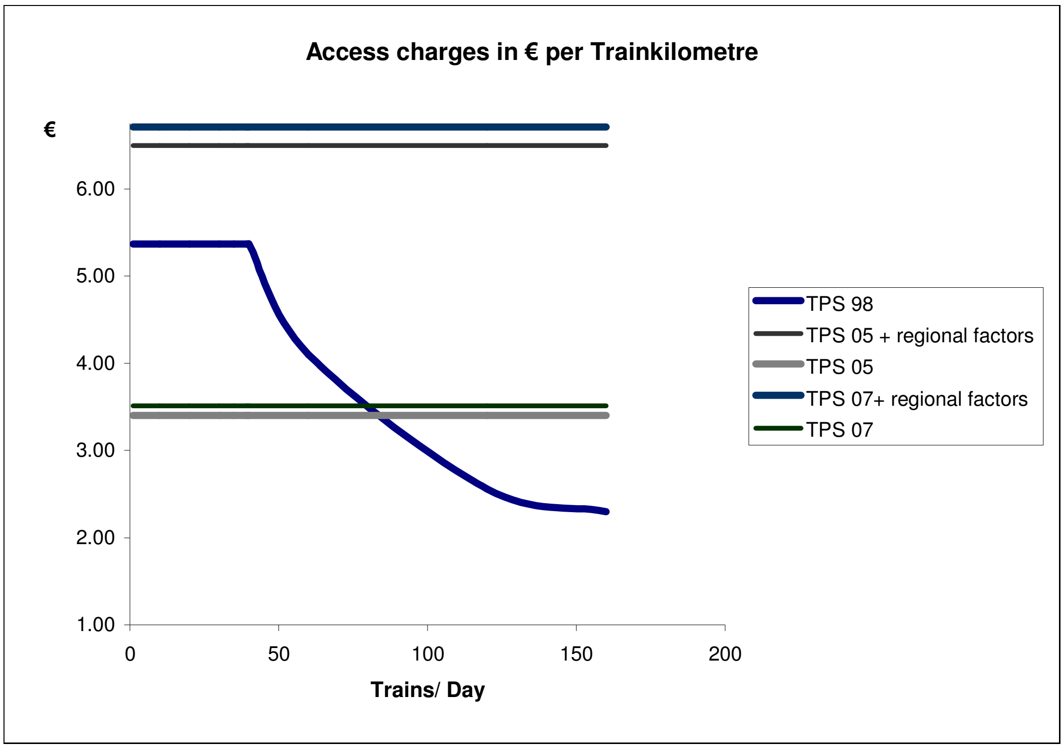


Source: DB competition report 2006.

Figure 3-4 Train Kilometres Purchased by DB Regio Competitors

Having set out the general development in urban transport, we turn to consider the development of infrastructure charges for a typical urban transport train. A typical urban transport train belonged to the category K3 (TPS 98) and to the F6 track category (TPS 01 and later) with a 65 percent mark-up for scheduled services. The inclusion of the regional factors shows the advantages and disadvantages of the former and the current charging regimes. From Figure 3-5 we conclude the following:

First, TPS 98 as a two part tariff provided essential incentives for more demand of tracks. Second, in contrast to the opinion of the operators, between 2001 and 2007 the base charge has risen infinitesimally. The inclusion of the regional factors shows however a different picture. In this case the access charge is about 40 percent higher than the highest charge of the TPS 98 charging scheme. Here there are several options conceivable. DB argues that low demand and high costs led to the introduction of the regional factors. In order to maintain these parts of the network the implementation of regional differentiation is inevitable. DB competitors argue that this is a case of raising rivals' costs since competition exists only in the urban transport sector. Additionally there are opinions expressing that DB favours with this pricing scheme long distance passengers' services, meaning that through the regional price differentiation long distance services are cross subsidized. However, due to the financing scheme of urban transport operators do not really regard regional factors as a major topic. Additionally DB Netz achieved to minimize complaints coming from the biggest urban transport authorities (eg. Hamburg, Munich, or Stuttgart), because their regions are not subjected to the regional factors. For the rest of the authorities where the regional factors are imposed, the additional costs due to the regional factors are financed by the regionalisation funds. These authorities still argue that it does not reflect common economic sense to raise charges when demand is low. Not withstanding the current situation, decreasing subsidies in the future will inevitably raise the topic of the regional factors. Urban transport authorities will have no other choice than to react in the ways already described above, especially to cut services. In that context the opinion, suggesting that DB Regio concentrates its activities in those markets where it has a real chance to sustain, may have a basis.



Source: Ewers & Ilgmann (2001), author's own calculations

Figure 3-5 The Development of Rail Access Charges in Germany

Third, compared to the current situation, TPS 98 enabled incumbent operators within the range of around 80 trains per day[10] to acquire transport services after competitive tendering easier than newcomer operators, since incumbent operators had already paid the fixed charge. Therefore, TPS 98 favoured DB Regio. For the regions, however, where there is no regional factor imposed, the charging level decreased compared to TPS 98, and stayed almost constant afterwards. However, the quasi-correlation between decreasing charges and increasing output level cannot lead to any conclusion regarding the price elasticity. In fact, the main reason for this development is the risk-free financing scheme of urban transport in Germany. Decreasing subsidies in the future should be able to give a better picture with respect to elasticity.

In order to study the effects of the regional factors further we consider at first a general charge increase an in the next steps we will take into account all single effects named by the interview partners.

[10] 80 trains per day imply a 30 minutes timing scheduled service.

Using data from the annual report of DB Netz Müller & Franz (see Müller & Franz 2007) calculated the upper limit of the demand elasticity of track access charges at which DB Netz can maximize profit respectively achieve a higher degree of cost coverage without suffering considerable demand decreases. According to their calculations DB Netz could raise track access charge by 5% and still increase the profit margin if the demand decrease is less than 6.33%, that is a critical elasticity of 1.27. Table 3-2 shows the impact of such an increase on the profitability of DB Regio for the year 2005.

Table 3-2 The Impact of a 5% Charge Increase on the Profitability of DB Regio

	Current situation	5 % charge increase
Consumption (in Bill. of TrackKm)	0.509	0.509
Average track charge (in €)	3.86	4.05
Track Costs (in Bill. €)	1.966	2.064
Cost Share of access charges	0.434	0.447
Additional Costs (in Mill. €)	0	98.3
EBIT	410	311.7

Source: Müller & Franz, 2007

In 19 it is clearly recognizable that in this scenario the profitability of DB Regio decreases by around 24%. DB Regio has in this situation few possibilities to cut costs. Long run labour agreements give no opportunities to adjust the number of employees respectively. In addition energy prices can not be affected by the firm itself. The only possibility that operators have is to shift financial burdens to the purchasers - the public transport authorities. Currently, this is exactly what occurs in the German short distance passenger sector.

Müller & Franz (Müller & Franz, 2007) observed in this respect, that a charge increase of 5% results in a fare increase of 6.2% if the additional costs are to be passed entirely to the passengers. We now move to the fare development for several public transport authorities, in order test whether passengers have to bear the regional factors or not.

In Table 3-3 it is clearly recognizable that the lower the regional factor the lower the average price increase. We disregard for this calculation inflationary tendencies. In the last column we can see the average yearly fare increase, which would be necessary in order to cover the additional (due to the regional factors) costs. Therefore, it can be safely concluded, that only parts of the additional costs are paid by the passengers. Here again the role of the financing system of public transport in Germany has to be pointed out once more. The funding scheme of public transport in Germany enabled authorities to finance additional costs from regionalisation funds.

Table 3-3 Average Yearly Fare Increase after the Introduction of the Regional Factors

Authority	Regional Factor	Average Yearly Fare Increase after the introduction of the regional factors (2003-2006) in Percentage	Necessary Fare Increase in order to cover Additional Costs in Percentage
VRR (around Dortmund/ Düsseldorf)	1.00	0.60	0.00
VBB (around Berlin/ Potsdam)	1.63	5.25	19.53
VBN (around Bremen)	1.28	2.56	8.68
VRM (around Koblenz)	1.15	2.57	4.65

Source: Author's own calculations

Since we recognized that only parts of the regional factors are integrated in the fare prices, we now take further reaction possibilities into account.

As already mentioned further possibilities to reactions on the regional factors are changes in frequency of services and the use of other transport means (e.g. busses). Based on data provided in the annual reports of the above mentioned authorities we calculate the correlation among the regional factors, the passenger fares, the track kilometres, the buss kilometres and the level of subsidies. With respect to the last, it has to be noted, that all authorities were unwilling to provide the respective figures, therefore it was inevitable to use the overall regionalisation funds as presented in 18. In Table 3-4 the correlation coefficients are presented.

Table 3-4 Correlation Matrix: Regional Factors and Possible User Reactions

Variable	Regional factor	Bus Kilometres	Track Kilometres	Passenger Fares	Regionalisation Funds
Regional Factor	1.000				
Bus Kilometre	0.713	1.000			
Track Kilometre	-0.493	-0.919	1.000		
Passenger Fares	n.s.[11]	-0.655	0.762	1.000	
Regionalisation Funds	0.384	n.s.	n.s.	0.368	1.000

Source: Author's own Calculations

In this correlation matrix all correlation coefficients as well as their sign are within the expectations. Starting with the correlation between the regional factor and the purchased track kilometres, a moderate negative correlation exists. This means that the higher the regional factor the lower the purchased track kilometres. However, due to the facts that some parts of the charge increases are passed to end passengers in the form of higher fares and some other parts of them are presumably paid from the regionalisation funds this correlation is only moderate.

On the other hand the very high negative correlation between the bus kilometres and the track kilometres as well as the relatively high positive correlation between the buss kilometres and the regional factors testify that the use of busses can be a real alternative. The higher the regional factor, the higher the bus kilometres within the region of one public transport authority. Likewise, the higher the bus kilometres, the lower the track kilometres. However, it has to be noted that within the considered period all authorities expanded their bus services. Therefore the correlation coefficients regarding bus services could be spurious. In order to have reliable evidence at this point, we would need a higher number of authorities as well as longer time series. The first was impossible since 5 other authorities denied to provide the respective data. The second is impossible since the introduction

[11] No statistical significance.

of the regional factors was in year 2003. As a result we keep the proposition that the use of bus services could be an alternative if the regional factors are extremely high, with the reservation that there could be a systematic statistical distortion in our calculations.

Finally, the seemingly surprising correlations between the passenger fares and the track kilometres respectively the bus kilometres are also within the range of expectations. Both figures are an expression of the cost structures of the different transport means. Passenger fares increase when a public transport authority uses more train services and decrease, when services within a certain region are offered predominantly with busses. For this cost structure there are mainly two reasons responsible:

- First, bus services are not subject to infrastructure charges. Therefore bus services do not bear these costs (the cost share of infrastructure charges for train services ranges between 25 percent and 40 percent of total costs).
- Second, busses are more flexible with respect to their length. For routes with low demand, it is possible to use smaller busses, which is not always the case for train services. This decreases operating costs.

Unfortunately the quantity and quality of the existing data is not the desired one, in order to estimate an aggregate translog cost model (in the sense of Friedlander and Spady) as already mentioned in Del. 7.1. Having detailed cost and output data it would be possible to calculate elasticities (since infrastructure charges can be regarded as an input price). However, we can conclude from the analysis made above, that within the effective financing framework, short distance passenger services are rather inelastic to infrastructure charges.

3.3 PASSENGER FARES STRUCTURES

Price discrimination with product differentiation has been used in the British rail industry over a long time, in order to increase revenue. This is not thought to be as sophisticated as the yield management systems used in the airline industry, but rail ticketing systems are always evolving (Wardman and Toner, 2003).

Historically, British railways charged fares based on distance travelled with a 50% mark-up for first class compared with standard travel. As the railways developed, the pricing structure also progressed. Lower priced excursion tickets for the leisure market and discounts for regular traveller in the form of season tickets were introduced. In 1980, fares were based on mileage but the mileage rate varied according to ticket type (first class, second class, cheap day return, weekend return and economy return). After that over the years, there has been a market based fare structure where prices are based on what the market will bear and aim to maximise revenue.

The level of complexity in the pricing structure of the UK fare system and the resulting difficulties for passengers is heavily criticised. It is often argued that there is little transparency for passengers (Hatano, 2004). The complexity situation leads many passengers to think that the current fare structure is an obstruction rather than an aid to making informed purchase decisions (Passenger Focus, 2007).

In terms of fare choice, the passenger is often faced with an array of tickets for each journey and it is not always straightforward to decide which option is best, e.g. the GNER service London – Edinburgh on ECML (600km journey taking 4.5 hours approx): return ticket varies from £25 to £268 (2003 prices) and there are 14 different ticket types. The full price tickets tend to be the most flexible whilst the cheaper tickets tend to be limited in terms of purchase time, train and peak service use. This ticketing structure is similar for most long distance operators; however all the train operating companies have their own discount and premium fares which create further confusion.

The complexity situation is further fuelled by the choice of operators. Following privatisation, there is considerable overlap on some routes, offering different service levels and fare structures.

Apart from the different fare structures available, there are various Railcard discount schemes that all train operating companies must participate in. having fulfilled a certain criteria, the cards offer various discounts to rail journeys. The main railcards are – disabled, family, network, senior and young persons. There are also special railcards for members of the armed forces, people on certain unemployment benefits etc.

Train operators use the yield management system to maximize revenue for each seat in order to maximize overall revenue and profits. This is advantageous for the government as it reduces the need for government subsidies. In terms of the passenger point of view, this system is favourable for some who are in a position to benefit from cheap advance booking fares with complex restrictions, but it not favourable to those who have less predictable and flexible travel needs and end up paying a high fare to travel (HCTC, 2006).

A survey done by Passenger Focus (2006) states that for commuters and leisure rail passengers, the main consideration when choosing a ticket is cost. They also look for some degree of flexibility. Business passengers are the least likely to have a choice of tickets available, but with the choice, they consider both cost and flexibility. Even though cost is the main factor, only a limited amount of searching takes place to for the best priced ticket, as 43% of business of business passengers and 32% of leisure passengers don not look around for the best priced ticket. Around 60% of commuter and business passengers and 50% of leisure passengers do not believe tickets are fairly priced. The majority state that they would travel more using rail if the fares were cheaper. Business passengers were most likely to buy their ticket on the day of travel even thought they had known about the journey for a week or more, in comparison to leisure passengers.

The Rail Passenger Council (2001, 2002) research found that passengers were sometimes quoted different fares when making initial enquiries, making them sceptical of the whole fare structure. Passenger Focus (2006) found that the majority of passengers relied on ticket office staff at train stations to provide them with the best value for money tickets, staff on the train and the internet were also seen as reliable sources of information. However, ticket machines, travel agents and telephone purchasing were least trusted by passengers. There is also reported to be a general perception that rail travel is expensive. The Rail Passenger Council state other issues include difficulties in:

- Understanding differences between tickets for different length journeys as a result of ticket prices no longer being linked to mileage;
- Understanding the calculation of season tickets and season ticket refunds;
- Understanding ticket restrictions; and
- Accepting the price differential between Standard and Saver tickets.

Simultaneously, the research found some favourable responses from passengers which included recognition that:

- Very cheap rail fares were available for those passengers who were flexible about when they travelled and who were willing to book in advance;
- Commuters to and from the large conurbations do enjoy comparatively cheap travel;
- There has been numerous improvements in certain aspects of service quality, e.g. online booking, improved onboard catering, better business facilities etc.

The way in which consumers respond to different pricing structures will influence the extent to which different pricing policies are able to meet their objectives. Work done by ITS for the UK Department for Transport aims to provide an insight into consumer response to complex tariffs (Department for Transport, 2004). The report identifies six important traits with regard to behaviour:

- People's ability to respond to price signals is constrained, not only by their circumstances and commitments, but by their access to the necessary information and by their ability and preparedness to access, understand and process that information.
- People's ability to access, understand and process information is limited by their mental capacity and experience but also by situational factors such as the time available to complete the task.
- People's preparedness to access, understand and process information depends partly on their personality, and partly on their engagement with the task. This depends on: (a) their perception of

its importance; (b) their perception of the motives of the body providing the information; and (c) their perception of the effort required to complete the task.

- The structure and presentation of information can have a large influence on people's ability or preparedness to process it. People show a strong tendency to rely on the most easily accessed information.
- When people cannot derive an analytical solution, or choose not to, they will resort to a heuristic or will seek to avoid having to make the choice. Most decisions in daily life are based on heuristics.
- People have a clear preference for simple price structures. Other things being equal, they will tend to choose the product or service whose price is most predictable.

Rail Focus (2006) state that only a minority of rail passenger feel that rail tickets are fairly priced and less than half claim to understand the range of tickets and fares available. The vast majority of travellers state that they would travel more frequently if rail fares were cheaper. A 20% reduction in fares was said to have some potential to encourage rush hour commuters to shift travel times in order to avoid the busiest periods.

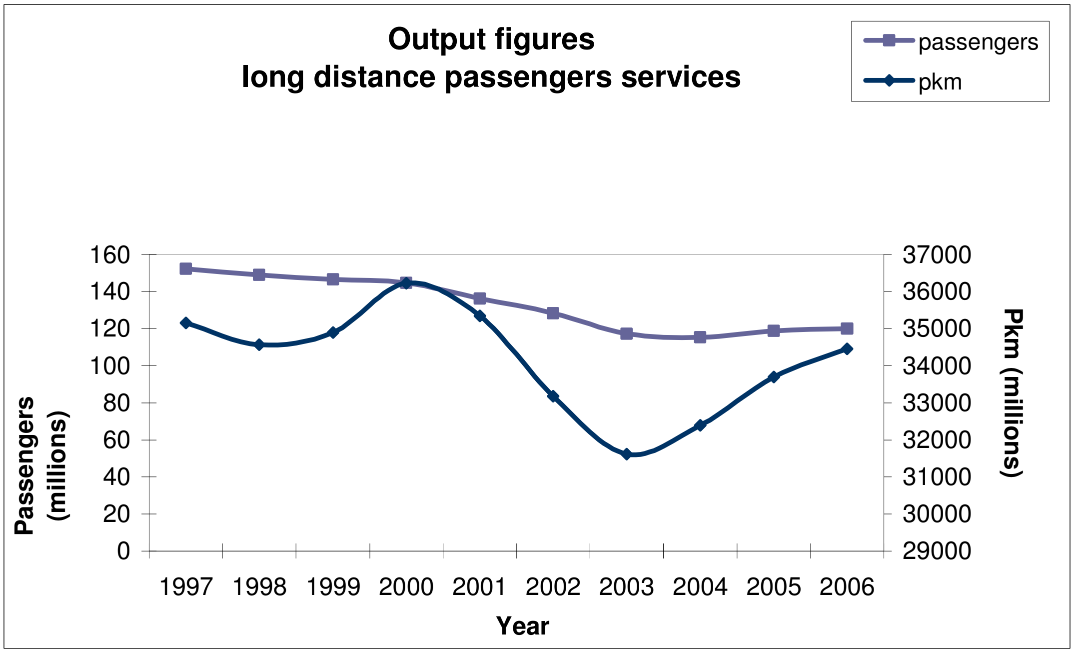
The UK will be introducing measures to make the purchase of rail tickets simpler and easier to understand. New fare categories will be introduced so that there is only a choice of three types of ticket – Advance (discounted, purchased in advance currently known as Leisure Advance, Business Advance, Value Advance and Apex), Off-peak (bought up to time of travel, but with restrictions currently known as Saver and Cheap Day returns) and Anytime (bought up to time of travel with no restrictions, currently know as Open tickets). The Association of Train Operating Companies (ATOC) state that the new ticketing structure is unlikely to lead to price increases and the regulation of rail fares (including the 40% that are price-capped on an annual basis) is unaffected by the changes.

In Germany, a fare structure based on the principles of yield management was introduced by DB in 2002. The new fare structure was no longer a uniform price (payable per kilometre), but rather a pricing scheme which tried to incorporate the passengers' willingness to pay. This pricing principle (yield management) is based on price differentiation according to demand elasticities for different user groups. The pricing principle is very similar to Ramsey pricing, differs however from Ramsey pricing with respect to the price level not the price structure. DB aimed with the new pricing scheme at a higher cost coverage since one of the main objectives of the railway reform in the 90's was (and still is) to enable DB to go public and a loss making company is not attractive for investors. Another aim of the new pricing scheme was to appease peak demand at key day and hours.

The main principles of the new fare system (so called PEP) were the following:

- In general DB switched from a fixed price per kilometre scheme to a declining one for travelled distances over 200km. This can be regarded as a reaction to the presence of low cost airlines since DB faces severe competition from low cost airlines in the last years.
- The former (the so called BahnCard 50) bonus program, in which passengers paid 50 percent of the fare by paying a certain amount of money per year was substituted by a bonus program (the so called BahnCard 25) in which, passengers pay only one quarter of the fare. However the principle of the two-part-tariff with this respect had been kept.
- Passengers could obtain further discounts, if they booked in advance and specified a particular train. The discount (10 – 40 percent) depended upon the booking time and a certain amount of disposable discount seas in each train.
- Further DB set a cancellation fee of € 45 for using a different train than specified. In addition, the use of another train than specified meant the passengers should pay back the discount.

The result of this reform was that DB faced hard opposition from passengers and negative media coverage. Passenger figures declined dramatically (see Figure 3-6) and revenues in the long haul decreased by around 7 percent. The negative press coverage was strengthened by a series of additional announcements such as the total concentration in IC and ICE trains. This situation evoked intervention by several politicians, who expressed publicly diametrically opposed positions and asked for an abolishment of the fare system. The government had therefore no other choice than to intervene. Finally DB in order to appease this negative development took back several elements of the fare reform. In particular the cancellation charge was revoked and the BahnCard 50 (50 percent fare discount) was reintroduced (see Matthes, 2004).



Source: Author's own calculations based on data from DB annual reports

Figure 3-6 Number of Passengers and Passenger Kilometres in the German Long Distance Rail Sector

Since the new fare structure and its amendments in 2003, the DB fare undergone no major changes in its structure. However, fares increased with a yearly average rate of 3.00 to 3.50 percent. The impacts of these increases are explored in the subsequent section.

3.4 EVIDENCE ON REACTIONS TO PASSENGER FARES

This section looks at the various elasticity estimates for rail fares. Table 3-5 and Table 3-6 include studies of both metros and suburban rail in its estimates.

Table 3-5 shows the short-run elasticity values for the UK are higher than the rest of the world. The overall average rail fare elasticity is -0.41 from a review of studies.

Table 3-5 Short-Run Rail Fare Elasticity Values UK and Non-UK

Location	Elasticity	Number of values
UK	-0.46	35
Non-UK	-0.33	20
Overall	-0.41	55

Source: TRL (2004) The demand for public transport: A practical guide

Table 3-6 shows that there is an increase in rail fare elasticity with time, as the long-run elasticities are higher than the short-run elasticities. This suggests that the ability to switch to an alternative form of transport following a price increase is higher in the long run. There are many possible reasons for this:

permanent switching to private transport may require time to purchase a vehicle and it takes time to search for suitable alternative travel arrangements via a different mode of public transport. Other lagged responses relate to home and job relocation, and in some cases it may take time for the information about a change in price to be noted and acted upon by irregular travellers.

Table 3-6 Rail Fare Elasticities (UK values)

Forecast period length	Elasticity	Number of values
Short-run	-0.46	35
Long-run	-0.65	2

Source: TRL (2004) The demand for public transport: A practical guide

Table 3-7 shows that a rail fare elasticity increase is higher for fare increases of a greater magnitude than that of a lower magnitude. It also increases in the long run.

Table 3-7 Effect of Magnitude of Fare Change on Fare Elasticity for Peak Rail Journey to Work [12]

Forecast period length	Low magnitude fare increase	High magnitude fare increase
Short-run	-0.31	-0.33
Medium-run	-0.32	-0.38
Long-run	-0.35	-0.45

Source: Mackett and Bird (1989)

Table 3-8 presents short-run UK rail fare elasticities (relating to suburban travel) in terms of peak and off-peak travel. The elasticity is much higher in the off-peak compared to the peak, this is due to the greater flexibility in travel in the off-peak which is largely dominated by leisure travel and peak is largely dominated by commuting travel.

Table 3-8 Short-run UK suburban rail fare elasticities by time of day

Period	Elasticity	Observations
Peak	–0.34	4
Off Peak	–0.79	5

Source: TRL (2004) The demand for public transport: A practical guide

Table 3-9 compares short-run fare elasticities for bus, metro and suburban rail. The overall mean elasticities are also given, averaged across all modes. The table shows that that Metro has the lowest elasticity values, both in the UK and non-UK and is lower than bus. This is due to the advantages metro has in terms of providing a rapid means of transport for commuters from the outer urban areas to the centre. Due to congestion problems, car and bus cannot really compete for these trips and the journey distance is too long to be walked. This is a generally a captive market unless travellers change job locations which is more difficult in the short-run. Suburban rail has the highest average elasticity, this may be due to the fact that many of these trips may be commuting trips from outside urban areas to the city centre and some commuters can work outside the main urban area and travel by car. The table shows that the elasticity values are on average higher in the UK than the rest of the world. This may be due to the UK having higher fares and poorer service quality than other parts of the world.

[12] (forecasts made over a period of ten years with fares increased in real terms each year – small increases being 1.5% per year and large increases being 5% per year)

Table 3-9 Comparison of Short-Run Public Transport Elasticities Across Modes

Mode	UK	Non-UK	Overall
Bus	-0.42	-0.38	-0.42
Metro	-0.30	-0.29	-0.29
Suburban rail	-0.58	-0.37	-0.50
Overall public transport	-0.44	-0.35	-0.41

Source: TRL (2004) The demand for public transport: A practical guide

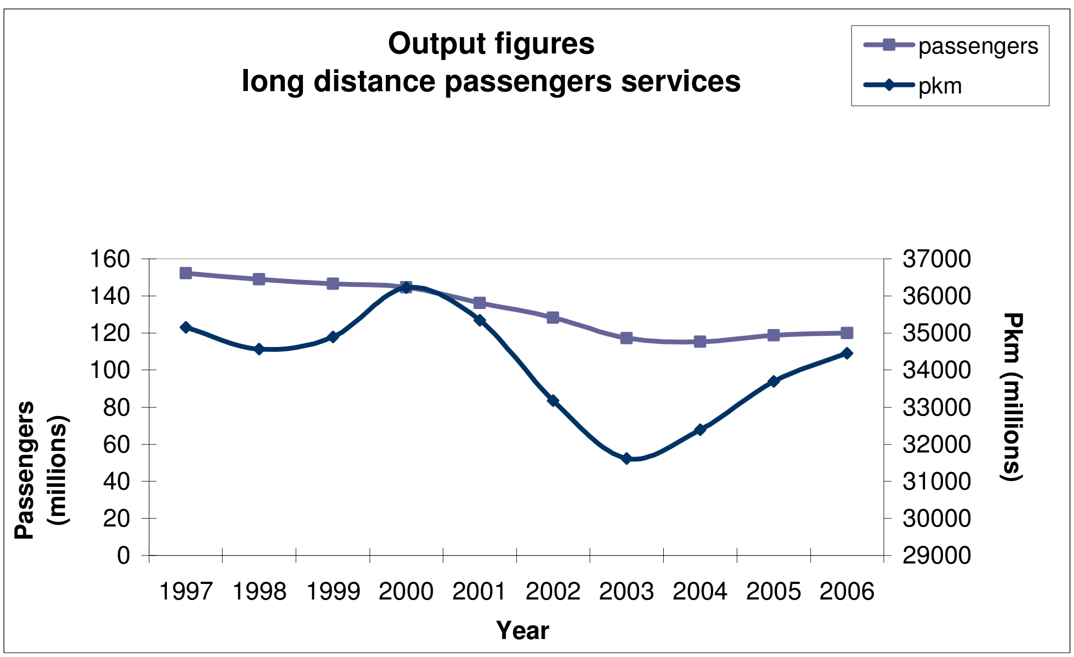
Table 3-10 illustrates fare elasticities by ticket type. The four ticket types considered were: first class and standard full fare where there are no travel restrictions, standard reduced fare which only permits off-peak travel and Apex where the ticket has to be bought in advance and travel restrictions apply. The elasticities are based on an analysis of annual ticket sales data by AEAT covering the period 1991 to 1999 for over 5000 flows. The values show that elasticity is higher when the tickets have no travel restrictions.

Table 3-10 Inter-Urban Rail Ticket Type Elasticities

Ticket type	Elasticity
First Non Season	-0.6
Standard Class Full	-0.7
Standard Class Reduced	-0.4
Standard Class Apex	-0.3

Source: Wardman and Toner (2003) from AEAT (1999)

In Germany, DB Fernverkehr dominates the long distance passenger market. There are just two exemptions of routes offered by other suppliers. Figure 3-7 shows the development of output figures.

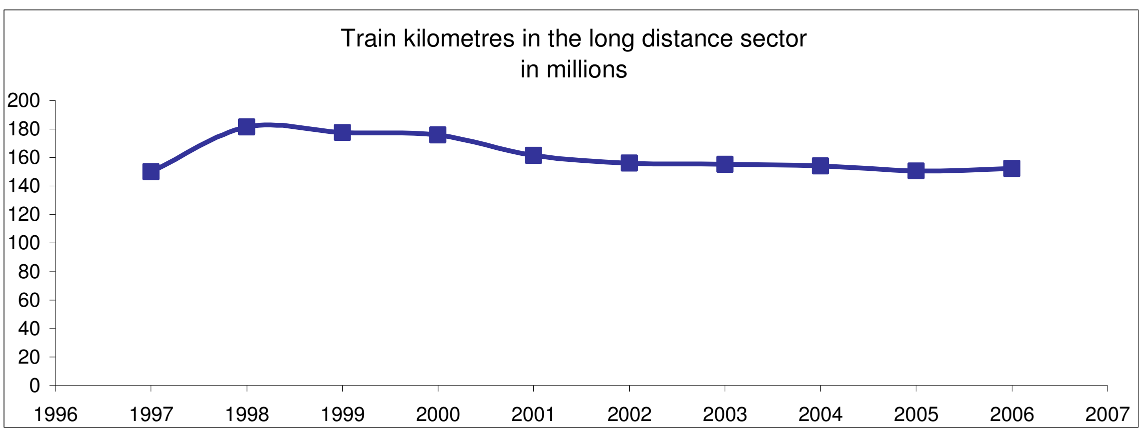


Source: Author's own calculations based on data from DB annual reports

Figure 3-7 Number of Passengers and Passenger Kilometres in the German Long Distance Rail Sector

As shown in Figure 3-7, the number of passengers has decreased. Within the observed period of time DB Fernverkehr lost around 20 millions of passengers. The main reason for that is the successive concentration of DB on high speed services (ICE trains). Within this time DB abolished a big part of the so-called Inter-Regio services. In addition, there are general economical cyclic effects. This can be seen more clearly in the development of passenger kilometres. However, both figures have stabilized, respectively risen within the two last years. There is no doubt that DB Fernverkehr in order to prepare the DB group's initial public offering optimised its routes by withdrawing less profitable routes. As already mentioned, economical cyclical effects was the main reason for this development. In addition, the effects of the new fare structure are clearly recognizable. The development of a kind of "passenger strike" as a result of the new fare structure is here recognizable in the decline of the years 2002 and 2003. This means on the one hand that trains transported fewer passengers and on the other hand that passengers travelled shorter distances. Taking all these into consideration it can be concluded that to a certain point DB Fernverkehr optimised its services; however the impact for the use of infrastructure was not as negative as in the passenger market. Therefore the development of train kilometres purchased by DB Fernverkehr declined as expected, but not as strongly as in the passenger market (see Figure 3-7).

In addition, it has to be noted that the long run development shown in Figure 3-7 is also strongly connected with the intensity of competition with other transport modes. In the long haul railway services face severe competition from airlines. Air transport has a decisive advantage compared to railroads, that is travel time savings. In particular, due to the boom of Low-Cost-Carriers in air transport in the last years, intermodal competition strengthened. DB Fernverkehr saw itself to try to defend its prior position. This explains also special fares offered by DB Fernverkehr for city pairs which are also served by LCCs. The shorter the travel distance the stronger the advantages of railways compared to airlines. On the other hand railways compete also with the private car. Here the situation reverses if we compare the competition of railways with airlines. Private cars have the well known flexibility advantages in comparison to the railways. Therefore we can conclude that in the short haul there are possible substitution effects between private cars and railroads and in the long haul there are possible substitution effects between air transport and rail transport.



Source: DB annual reports.

Figure 3-8 Train Kilometres of DB Fernverkehr

We turn now to the passengers' reaction with respect to fare set. Taken into account the possible substitution effects described above, it is not advisable to study railway fares on their own, but rather to take interdependencies into account. Mandel et al. (Mandel et al., 1997) studied these interdependencies within the transport planners four step process[13]. Their modelling activities resulted in a disaggregate Box-Cox Logit model. In the following we will describe briefly the Mandel et al. estimation. At first, the use of the Box-Cox transformation enabled to take the problems of the assumption of linearity of the utility functions under control. Second, it was possible to use different values of time for different transport modes. Table 3-11 shows the incorporated model variables. The

[13] The four steps process refers to trip generation, trip distribution, mode choice and network assignment.

data used for this study (a sample with 62,982 observations) were provided by the German ministry of transportation and were related to the years 1979-1980.

Table 3-11 Variables of the Box-Cox Logit Model

Variable	Restricted Model	"Rich" Model
Travel Cost	×	×
Travel Time	×	×
Frequency per Week	×	×
Trip Purpose		×
Socioeconomic Variables (age, sex, etc.)		×

Source: Mandel et al. (1997)

Mandel et al performed several estimations for linear as well as Box-Cox Logit models. In the following we present selected examples of the estimation results with respect to elasticities.

Table 3-12 Estimation Results: Mode Choice Model

Characteristics			Restricted Model	"Rich" Model
Elasticities	Travel Cost	Plane	-0.69	-0.62
		Train	-0.38	-0.24
		Car	-0.02	-0.04
		(t-statistic)	(-6.46)	(-5.48)
	Travel Time	Plane	-1.79	-1.69
		Train	-1.14	-1.00
		Car	-0.15	-0.14
		(t-Statistic)	(-15.60)	(-15.14)
	Frequency	Plane	0.16	0.10
		Train	0.29	0.08
		Car	-	-
		(t-Statistic)	(2.31)	(1.72)
Value of Time (€/min)		Plane	1.28	1.63
		Train	0.25	0.37
		Car	0.51	0.56
Power Transformation λ			0.07	0.24
Final log-likelihood Value			-1306.22	-1189.35
Rho-squared			0.21	0.28

Source: Mandel et al. (1997)

As illustrated in Table 3-12, the demand elasticity of using the train is in both models between the demand elasticity of plane use and the demand elasticity for the use of the air mode. Here it has to be noted that the computed elasticities show weight aggregated values. Nonetheless that the study is based on very old data, it can be safely subsumed that the demand for long haul train services in Germany is rather inelastic. In addition the results with respect to the value of time seem to be more reasonable than in linear models. The value of time for the use of air services is higher than the value of time for the use of long haul train services, and this on its part higher than the value of time for the use of private cars.

We conclude, for this part of our analysis, that, despite the higher degree of differentiation of the new DB fare structure and the opposition by the media and passenger organisations, passenger demand for rail services remained relatively constant or decreased slightly, a fact which strengthens the assumption of an elasticity less than one (as we all already know from theory travel demand is a derived demand). The results of the Mandel et al study just confirm this assumption.

4 ASSESSMENT, CONCLUSIONS AND RECOMMENDATIONS

4.1 SUMMARY

Charging in the rail sector has, over recent years, made a number of moves towards greater efficiency and this has tended to lead to a greater degree of differentiation in the charges. Whilst concerns regarding user reactions have featured in the debate about infrastructure charging systems, they have not been the subject of detailed research. Instead, research has tended to focus on the design of infrastructure charging regimes which, in principle, promote efficient use of the infrastructure, efficient investment or which enable a particular degree of cost recovery.

One can postulate that rail infrastructure charges might have two principal effects on train operators. Firstly, they might affect their behaviour, in terms of their use of the infrastructure and the way they operate their services and, secondly, they might affect the charges that train operators make to their customers, be they passengers or freight forwarders. Furthermore, there are likely to be differences between reactions and impacts within the passenger as compared with the freight market.

This work package aimed to develop a better understanding of the ways, in principle and in actuality, in which users react to differentiated charges in the rail sector and propose a methodology for determining appropriate levels of differentiation. Our research focuses mainly on rail infrastructure charges, rather than on charges to end-users, on the basis that there is less existing research into reactions to rail infrastructure charges and that it is this area that is thought to be more directly relevant to the European Commission. An interim report, D7.1, preceded this deliverable. It comprised a review of the policy and academic literature, a series of case-study investigations, including a round of 25 interviews with industry stakeholders, and a review of research methodologies that might be employed.

One early finding was that, whilst infrastructure charges are a potential influence on train operator behaviour, other cost elements for train operators (staffing costs, train operating costs etc) and demand elements (demand reactivity to price levels, to quality of service, willingness to pay, etc) would also be expected to be important influences on the market. Secondly, whilst we were able to gather information about infrastructure charge categories and levels for the selected case study countries, we very often encountered a lack of even the basic information about precise infrastructure charge quantities (i.e. train-paths, or train-km) bought for each category.

Hence, it was concluded that a systematic analysis of the impact of infrastructure charge differentiation seems an extremely difficult prospect at this point. Furthermore, in some situations, infrastructure charges may elicit no reaction at all on the part of train operators, due to external influences and mechanisms of compensation being in place.

Nevertheless, whilst reactions may be difficult to analyse and, in certain situations, relatively limited in scale, our interviews did uncover which sorts of parameters have been affected. The details of these findings were given in D7.1. Two issues are worth re-iterating here. Firstly, there was some interesting discussion of the share of train operating costs comprised of infrastructure charge-payments, and we have come to the view that the scale and form of reaction to infrastructure charges is Likely to depend crucially on these cost shares. Secondly, in all of our sets of interviews, freight operators indicated a greater degree of sensitivity to infrastructure charges than did passenger operators.

In light of the data availability problems encountered, it was agreed that the final phase of the work package pursue the following streams of work:

- Case study work focused on the Freight market in Britain;
- Case study work focused on the freight market in France;
- Case study work focused on rail freight through Eurotunnel;
- Modelling work based on the freight market in Britain;

- Simulation modelling of the downstream market using Quinet and Meunier's techniques;
- Case study work on the role of Regional factors in Germany;
- Case study work to analyse impacts in relation to passenger fares in Germany; and
- A review of passenger fares elasticities and attitudes to different fares structures.

In addition, it was agreed that a theoretical assessment be made to explore what data would, ideally, be desirable for a more analytical investigation into reactions in the future. This theoretical assessment is summarized in the next sub-section, followed with our overall conclusions in section 4.3.

4.2 THEORETICAL ASSESSMENT AND DATA REQUIREMENTS

One of the possibilities to calculate user reactions and elasticities in the railway sector would be via the use of aggregate models such as that used by Friedlaender and Spady. This approach is, relatively speaking, less data hungry than some alternatives, so in the current context of poor data availability, it perhaps presents greater opportunities for implementation.

Friedlaender and Spady (see Friedlaender & Spady, 1980) started from the main assumption that costs of transportation should be treated just like any other firm's inputs. In addition, we know well from microeconomic theory that a cost function measures the minimal costs in order to produce a certain level of output, given the input prices. In other words firms substitute inputs according to their prices in order to minimize costs for the provision of their services. For this reason it is beneficial (given that infrastructure charges represent input prices) to start with the consideration of a cost function. An application of Shepard's Lemma leads then to the input demand functions. Thus Friedlaender and Spady consider a firm using labour, capital material, energy, rail transportation and truck transportation in order to offer their transport (freight) services.

In addition, Friedlaender and Spady argue for the use of a short run cost function. In their analysis capital and material are constant in the short run. This argument has a theoretical and a technical dimension:

- The theoretical dimension refers to the impossibility of a firm to substitute inputs in the short run instantaneously. Thus, an estimation of a short run cost function helps to avoid estimation bias. This seems to be the case also in the German railway sector. For instance if track access charges decrease, freight operators can hardly find additional locomotives in the short run in order to generate more transport activity.
- The technical dimension refers to the need to model capital costs and calculate *real economical capital demand*. Economical capital costs answer the question *"what are the procurement costs of capital now"* and not *"what were the procurement costs of capital x years ago"*. It is apparent that the use of accounting data in this case distorts the costs of capital, because accounting data are historical data. In order to calculate capital costs properly, internal firm data is required and sophisticated modelling work is necessary (e.g. perpetual inventory method). Thus, the problem of calculating the price of capital can be avoided by using a short run cost function.

As a result of the arguments above the following functions are assumed:

$$C_S = C_S(Y, K, M, P_L, P_T, P_R)$$

$$T_S = \frac{\partial C_S(Y, K, M, P_L, P_T, P_R)}{\partial P_T}$$

$$R_S = \frac{\partial C_S(Y, K, M, P_L, P_T, P_R)}{\partial P_R}$$

C_S denotes the firm's short run cost function. P_L, P_T, P_R refer respectively to the prices of labour, truck transportation and rail transportation. Y, K and M refer to the fixed variables of Output, Capital and Material. Therefore, for further mathematical expression they will be denoted with the vector $X = Y, K, M$. Finally T_S and R_S denote the input short run demand functions for track transportation respectively rail transportation.

Further, Friedlaender and Spady advocate the necessity to model transport prices, because transport rates alone cannot fully reflect shipping costs, since inventory costs play an important role as well. Their proposal with this respect is related to additional shipment characteristics, which are different for each transport mode. Hence, input prices are modelled as follows:

$P_i = \psi^i(r_i(q^i), q^i)$ where i is applied for T and R. That means, that transport price P_i is a function ψ^i of the transport rate r_i and the special shipment characteristics q^i associated with transport mode i.

With respect to the functional form Friedlaender and Spady proposed a translog cost function. We abstract at this point from the well known advantages (mostly related with flexibility) and the disadvantages (mostly related with the necessity of large samples and sample homogeneity) of the translog function. Translog cost functions are nowadays widely known and used in science as a simple and helpful econometrical tool.

The corresponding possible translog cost function for railways as a second degree approximation has the following from:

$$\ln C_S = \alpha_0 + \sum \alpha_i \ln P_i + \sum_h \beta_h \ln X_h$$
$$+ \frac{1}{2} \sum_i \sum_j \gamma_{ij} \ln P_i \ln P_j$$
$$+ \sum_i \sum_h \delta_{ih} \ln P_i \ln X_h$$
$$+ \frac{1}{2} \sum_h \sum_s \varepsilon_{hs} \ln X_h \ln X_s$$

In addition cost share equations are incorporated in the model in order to counter the problem of data availability on the one hand and ensure economical adjustment of firms on the other hand.

$$S_i = \frac{C_i}{C_s} = \frac{\partial \ln C_s}{\partial \ln P_i} = \alpha_i + \sum \gamma_{ij} \ln P_j + \sum_h \delta_{ih} \ln X_h$$

with S_i representing the cost share of mode i and C_i the costs of the respective mode. In addition a cost function is homogenous of degree one in input prices and hence the following restrictions on parameters are used:

$$\alpha_L + \alpha_R + \alpha_T = 1$$
$$\gamma_{iL} + \gamma_{iT} + \gamma_{iR} = 0 \qquad i, j = T, R$$
$$\delta_{iK} + \delta_{iM} + \delta_{iY} = 0 \qquad i, j = T, R$$
$$\gamma_{ij} = \gamma_{ji}$$

After the estimation of this model the derivation of the direct elasticities ε_{ii} as well as cross elasticities ε_{ij} is given by the formula:

$\varepsilon_{ii} = \frac{\gamma_{ii}}{S_i} + S_i - 1$, and

$$\varepsilon_{ij} = \frac{\gamma_{ij}}{S_i} + S_j .$$

Turning to the data requirements it has at first to be noted that this kind of research analysis described above has been applied very often for American railroads in the last years (see Bereskin, 2001, see Braeutigam et al., 1984). Almost all researchers who estimated similar cost functions used publicly accessible data provided mainly by the Association of the American Railroads, the Surface Transportation Board and the Bureau of Transportation Statistics. Although the American rail sector is deregulated since Stagger's Act, the vertically integrated firms are willing to provide detailed data to all the above mentioned authorities/association. In particular two publications of the Association of the American Railroads can be proved to be very valuable:

1. The analysis of Class I Railroads
2. The Railroads Cost Recovery Indexes

The Analysis of Class I Railroads contains for each individual firm almost all exogenous variables needed to estimate a function of the Friedlaender/ Spady form. Thus, we conclude that a data sheet with a similar structure with "*The Analysis of Class I Railroads"* would be inevitable in order to perform the estimation described above. In particular, all relevant input prices (Labour, truck transportation, rail transportation) as well as output and output related data (e.g. tonne-miles, average length of haul, average shipment size of the commodity carried and the average density of the commodity carried) should be included (similarly to the Analysis of Class I railroads) in a respective data sheet for Europe.

Additionally, the *Railroads cost recovery Indexes* includes all necessary cost information. Hence it is possible to derive the cost shares. The fact that data preparation is in index form, does not have any considerable effect in estimation results. Besides, data preparation in an index form makes it for firms easier to be willing to provide internal firm data, because in this case they will not reveal absolute cost values. Hence, cost information on each single input is necessary in order to complete estimation and ensure that firms adjust inputs, if input prices change. In particular, the data required, for a similar data base in Europe, are the cost shares of each single input described above (labour, truck transportation, rail transportation), as well as an index on the development of short run variable costs.

We close this theoretical assessment with a comment on the translog function. In order to obtain robust estimations with a translog function it is necessary to have large samples. The reason for this is the number of parameters to be estimated. For each additional exogenous variable incorporated in the model, the quadratic and the cross terms have to be constructed. Therefore, the number of parameters to be estimated increases disproportionally high to the number of variables used. A cross section analysis at this point would not be enough, in order to yield reliable conclusions. For this reason a panel data analysis is required. That means that the proposed data should be collected for longer periods of time (at least 5 - 10 years).

4.3 CONCLUSIONS

Infrastructure charges were introduced in Britain in 1995 and, when reviewed in 2001, were effectively halved for freight operators. Over the period, growth in freight traffic has been quite remarkable, in the order of 50% over 12 years. Within this, growth has been particularly notable in coal traffic, which rail is inherently better-suited to carrying, and in construction traffic which appears particularly price-sensitive. However, rail freight growth actually started in 1995, and we do not observe a major change in the trend around the time of the reductions in infrastructure charges introduced in 2001. Nevertheless, the structure of charges pper to be incentivising operators to reduce impact of rail freight on the network, eg by operating less-damaging rolling stock and by requiring fewer slots to operate a particular service. Further changes are soon to be implemented, involving greater differentiation and increased charging levels for freight-only lines. It will be interesting to monitor any observable impacts of these forthcoming changes.

Infrastructure charges in France were first implemented in 1997 and there have been several changes to charging structure and levels over the period. A differentiation between “rapid” (high value) freight traffics and other freights was introduced. The circulation charge for freight doubled between 2002 and 2009. While freight infrastructure charges went up as described, freight traffics went on a downward trend from the end of the 1990’s. These evolutions may seem, at first sight, to be closely related but the linkage between charges and traffic remains unclear and probably low. First, a notable effect occurred when reservation fees were implemented and led to the suppression of “facultative” paths that were unused. Second, even though it increased globally, the charge level still represents a low share in operators’ costs, especially for SNCF (around 8%), whereas the evolution of traffic showed important shocks that seem to be much more related to the changes in SNCF’s freight strategy. Indeed, reorganization plans, railway strikes, the liberalization of fret services and economic globalisation have extensively confused the price signal and impacted the traffics at a much higher degree than the relatively small signal of infrastructure charge could. However, set now at higher levels, and in a more stable environment, infrastructure charges may play a stronger role in the future.

Eurotunnel provides an interesting case, as rail freight through the tunnel has performed somewhat disappointingly over a number of years and the charges faced by freight operators have consistently been cited as a potential cause of this poor performance. Having originally had a design capacity of c10 million tonnes, freight traffic grew during the first 3 years of operation to three million tonnes in 1997. However, it then stagnated until 2000, before declining to just over one million tonnes in 2007. The original charges were devised in the midst of rail re-structuring in both Britain and France, with no actual reference to the market. Furthermore, the monopoly and state aid aspects of the market rendered them irrelevant as signals to the market. Following the cessation of the Minimum Usage charge in 2006 and continued decline in rail freight traffic through the tunnel, discussion between the key stakeholders led to another set of revised charges being announced in autumn 2007.

Since the removal of state aid, opening up of the market and establishment of the new charging regime, traffic appears, on the whole, to be responding positively, though it is too soon to say whether this is a sustained turn-around.

The effect of changes in rail access charge regimes on rail and road traffic in Britain have been modeled using the LEeds Freight Transport Model (LEFT) (Fowkes et al (2006)). Six scenarios/policy tests examined the effects of:

- Removing current track access charges;
- Halving current track access charges;
- Doubling current track access charges;
- Quadrupling current track access charges;
- Introduce a structure of fixed and variable track access charges; punishing short distance rail traffic;
- A fixed and variable access charge stimulating long distance traffic.

By using LEFT, we have been able to explore the potential impacts of variations in infrastructure charging in isolation from any other changes that might impact on the rail freight market. We have found that by removing access charges, rail tonne-kilometres increase by 9%, reducing road traffic by almost 2 billion tkm, just 1%. This highlights an underlying lack of competitiveness of rail in key freight markets such as Food Drink and Agriculture and Construction, because of high captivity to road transport, given the short distances involved and the lack of suitable rail infrastructure. We have examined the sensitivity of the rail market to levels of access charges and found that rail is slightly less sensitive to access charge increases than it is to equivalent decreases. If we introduce different structures of access charging over distance bands, approximating a fixed and variable charging regime, we have shown how we can incentivise rail traffic over the longer distances where rail is more competitive and environmentally more beneficial.

Several conclusions can be drawn from the simulation modelling exercise:

- In cases of imperfect competition –a frequent situation in the transport field- and on the ground of pure welfare calculations, the optimal tariff is highly dependent on the specificities of the situation:

the level of the cost of public funds, the nature of competition (Cournot, Bertrand, …), the specification of the demand functions. And generally speaking our knowledge in these fields is often poor. This point advocates for more research on the field of imperfection competition, especially on the applied grounds: data on costs, prices and elasticities, nature of competition.

- Market structure has an important impact on the optimal IC; so the ICs of two services similar in everything except the market in which they are run should differ. Generally speaking, IC levels for monopoly should be lower than for a duopoly.
- The possibility for IC differentiation between two sub-markets can stem from differences in costs or demand or market structure (or a combination of these features) of these services.
- In any case, IC differentiation brings small welfare changes when the two - or more- sub-market situations are close to each other; in such cases, the tiny improvement in welfare may lead to huge consequences on the distribution of welfare between the agents: the operators, the infrastructure manager and the consumers.
- Demand function differences –namely elasticities- have consequences never negligible and sometimes tremendous. The effect may depend on the nature of competition in the market.
- As far as costs are concerned, differentiation between two operators whose operating costs are different seems to bring minor welfare gains that could possibly be more important if these operators are monopolies than if they bear competition with another mode. In the case of two links whose infrastructure costs are different- or two operators whose damages to the track are different- differentiation may have observable welfare consequences and is to be recommended, especially when the operator is a monopoly; in the case of a duopoly, the market power of the operator is limited by the operator of the other mode and differentiation, though desirable, may be less important.
- A two part tariff bearing a term linked to the service (train-km) and another one linked to the occupancy of the service (e.g. passenger-km) seems to bring a non negligible welfare increase, to the extent of a change in its distribution: the infrastructure manager's revenue may decrease a lot as compared to a situation of purely linear tariff (proportional to the number of train-km).
- In some cases, averaging the tariffs of several services may have important effects if these services have widespread characteristics of costs and demand; in particular, it may happen that the average tariff excludes some profitable services, ending up in a large loss of welfare.
- In case of a duopoly on track – meaning that two rail operators compete on the same track - welfare does not seem largely impacted by an averaging of tariffs.
- Last but not least, making non differentiated IC come closer to optimal IC levels could be much more worth than trying to differentiate finely around the initial IC levels if those levels are far from the optimal ones.

The main findings relating to the Regional Factors in Germany can be recapitulated as follows:

1. The introduction of the regional factors led to multiple reactions of public transport authorities. First, a part of the charge increase was integrated in passenger fares. Second, the higher the regional factor the lower is the purchased track kilometre. The reason for that development may be found on the one hand in optimisation of passenger services and on the other hand in the possibility to use other transport means.
2. Passengers react predominantly inelastic to fare increases. The main reason for this is that qualitative travel elements (e.g. travel time) play a huge role in travel decisions.
3. The track access charging scheme of 1998 set as a two-part tariff comparatively better incentives for users to utilize more tracks. Its abolishment can therefore only be explained with competition and lobbying issues.

Additionally, an interesting observation is that track access charges in Germany lack of clear economical principles. Mainly charges are cost based. However, DB Netz uses demand arguments to justify several differentiation elements. The regional factors are one of these elements. A second one is the product factor for high utilized tracks. This fact is also confirmed by DB Netz officials. An assessment of such tariff schemes' effects is therefore complicated and requires sophisticated econometric analysis. Apart from researchers' difficulties tariff structures with no clear economical principles reveal the political dimensions of infrastructure charges. Additional differentiation elements are not classified under the company's main objectives, but rather under the real world needs to achieve political acceptability of the charging scheme.

Data availability issues have placed constraints on the level of analytical detail that we have been able to achieve. However, the case study research has helped to identify key trends and issues, whilst we have also been able to pursue some interesting modelling ideas. It is clear that modelling can help in identifying the cases where welfare curves could be quite flat (meaning that the final impact of IC level is rather low), and therefore in giving indications about the degree of desirability of infrastructure charge differentiation, given some minimal data requirements on the market segments concerned.

Besides data requirements, the research field of imperfect competition in rail markets seems to be quite important if we want to explore more these important issues and have a better understanding of what the final indirect impacts of infrastructure charging are, once interactions between competitors and demand converge to an equilibrium. Trying to open and explore this "black box" of interactions is highly desirable, since the very basic representations such as perfect competition assumptions are clearly far from being fulfilled.

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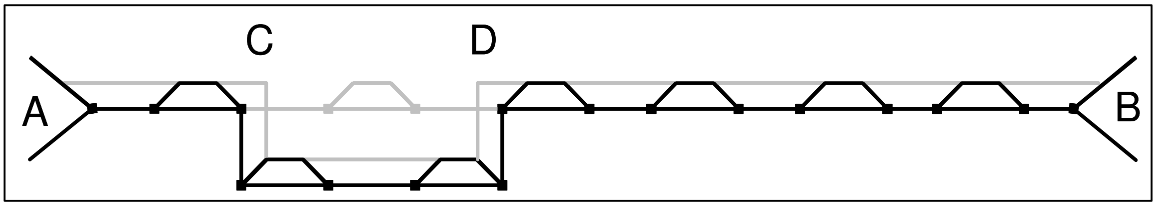
APPENDIX 1

MODELLING REACTIONS IN THE GERMAN RAIL FREIGHT MARKET

The complexity of railway systems on the one hand and the lack of data on the other hand make an assessment of the effects of track access charges for freight services very difficult. As a result in order to study potential effects we abstract from reality and consider an exemplary track (see Figure A-1)[14]. Kunze (see Kunze 2006) used this type of analysis in order to study the effects of the different German track access charging regimes primarily on investment and further on demand.



Source: Kunze, (2006)

Figure A-1 Exemplary Track

The current status between A and B is a single track with a slow-speed point (the black line). Kunze defined therefore the following investment possibilities:

- IS1: Removal of the slow-speed point
- IS2: Construction of a direct single-track connection (the grey part between C and D)
- IS3: Twin-track upgrading of the whole track.

The first consideration is to calculate the fixed costs for the three investment possibilities. To that end several assumptions were to meet and engineering costs (as accepted by the German government) were used. We start with the calculation of the construction costs in the following formula:

$$D_t(IS) = \sum_{i=1}^{e} \frac{\rho - 1}{\rho} \cdot (1 + {}_{\Delta}p)^t \cdot \frac{K_i(IS)}{\rho^{n_i} - 1} \cdot Z$$

With: $D_t(IS)$: Total construction costs for investment IS and period t

$K_i(IS)$ Construction costs for component i within investment IS

Z: Share of the costs covered by subsidies

$\frac{\rho - 1}{\rho} \cdot \frac{1}{p^{n_i} - 1}$: Discounting factor with: $\rho = \frac{1 + {}_{\Delta}p}{1 + r}$, were **r** the interest rate and ${}_{\Delta}p$ is the price index.

In order to derive the fixed renewal costs we multiply construction costs with the constant rate $r_{Ren.i}$.

$$F_{Ren}(IS) = \sum_{i=1}^{e} K_i(IS) \cdot r_{Ren.i}.$$

Taken into account both formulas above the total fixed costs for each investment possibility are given by:

$$F_T(IS) = F_{Ren}(IS) + D_t(IS).$$

In order to calculate the formulas given above for the exemplary track there are several assumptions to be made. We proceed with the most important ones. At first all route characteristics were precisely defined. The distance among the stations was set for instance at 5,000 meter The maximum train speed as an element of the track was set to be 120 Km/h. Next ${}_{\Delta}p$ was defined as 1% and the interest rate as 4%. Z was set due to information taken from the annual reports of DB Netz at 26%. The construction costs of the single component were taken from the regulators (EBA) cost directive. A blanket rate of 6.8% of net construction costs was used for the cost of planning. With respect to the renewal costs Table A-1 shows the renewal cost share for the main cost components (as a percentage of the construction costs).

[14] The following analysis is based on Kunze (2006).

Table A-1 Renewal Cost Shares

Cost Component	Economic life (in years)	Renewal Cost Share
Real estate	∞ (100)	-
Road bed	75	0.00350
Walls	75	0.00350
Tunnel	75	0.00140
Viaducts	75	0.00420
Intersections	75	0.00420
Noise protection	25	0.00070
Rail system	25	0.03080
Signalling	20	0.02100
Communication	12	0.03500
Planning	25	-

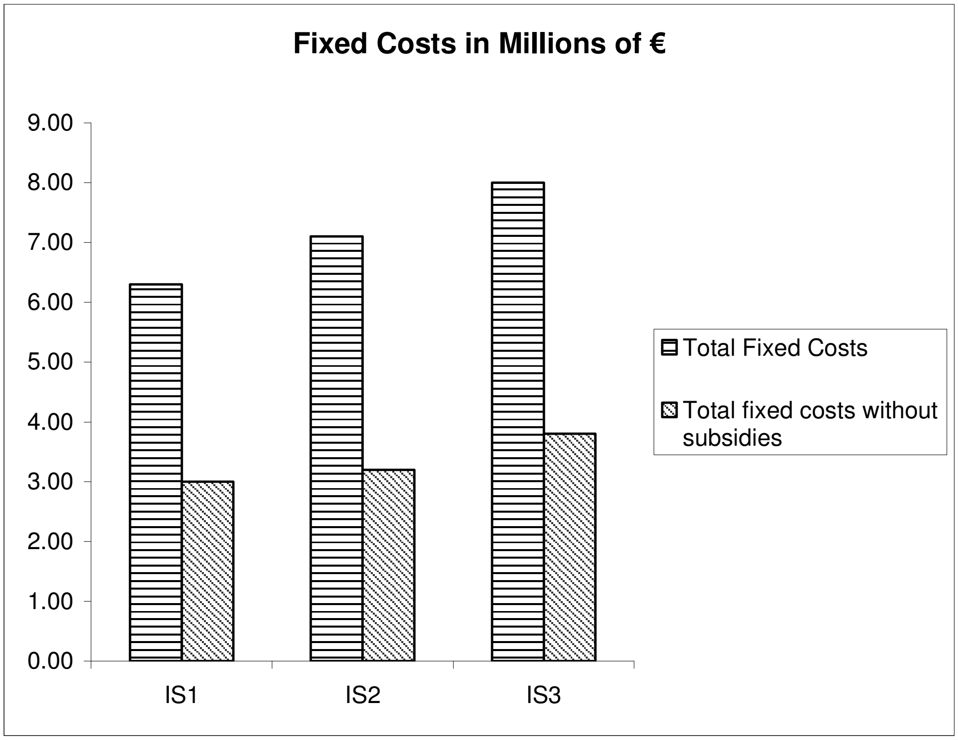
Source: Kunze, (2006)

Taking into account all considerations made above the total fixed costs are shown in Figure 3-4, infrastructure operating costs were set with 0.001 € per track kilometre (see Garstenauer, 2005). The next step is to calculate the maximal number of trains for freight services. This leads to the necessity to construct a train schedule as close to reality as possible in order to find the maximal number of tracks for freight transport. For this schedule several additional assumptions have to be made. To that end a train pair per hour for passenger services was assumed, and a nightly five hours service stop was taken into account. Using the FBS software Kunze constructed two schedules (see Table A-2) and calculated further with them. The results of these schedules were used subsequently in order to calculate effects of the different charging regimes on demand. Operating schedule 2 incorporates the priority of passenger services by using buffer times, which is the reality for Germany. Therefore the supply of tracks for freight services is in this case lower.

Table A-2 Operating Schedules for the Different Investment Possibilities

	Operating schedule 1				Operating schedule 2			
	Passenger Services		Freight Services		Passenger Services		Freight Services	
IS	track supply	average transport-time in min	track supply	average transport-time in min	track supply	average transport-time in min	track supply	average transport-time in min
1	13,870	55	15,719	48	13,870	48	12,201	55
2	13,870	50	15,719	47	13,870	41	13,870	55
3	13.870	47	52,706	45	13,870	47	63,802	47

Source: Kunze, (2006)



Source: Kunze (2006)

Figure A-2 Total Fixed Costs

After calculating fixed and operating infrastructure costs and the maximum number of tracks for freight services for each investment possibility, we turn to demand for freight services. Kunze assumes a constant elasticity of demand for freight train services. In particular he assumes that the demand function has the following form:

$$y(B;IS;TP) = A \cdot p^{\varepsilon} \text{ with } p = p(B;IS;TP)$$

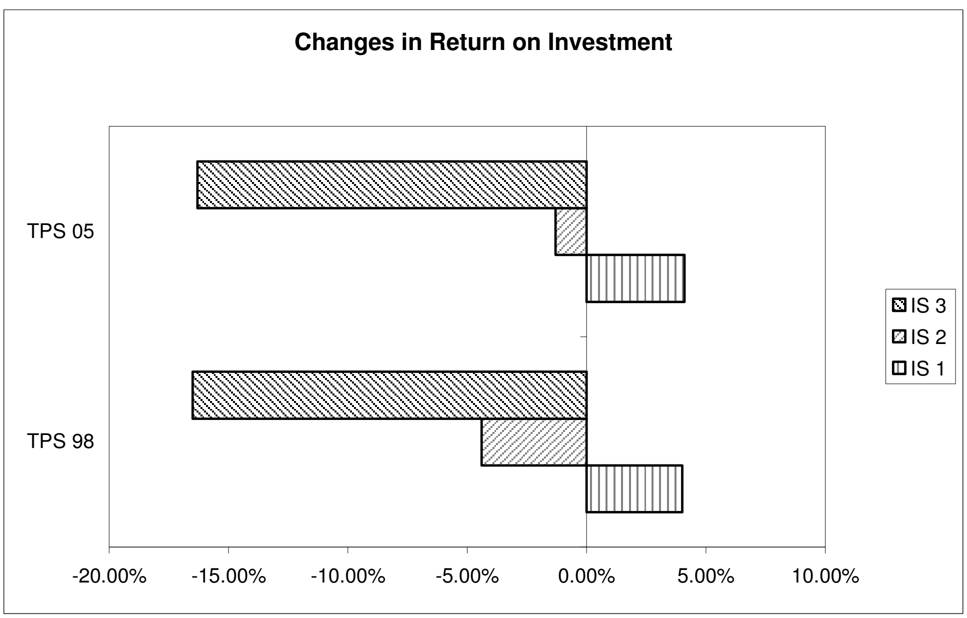
The demanded quantity y for railway services and the price depend therefore on the operating schedule B, the investment possibility IS and the access charge TP. A is a positive constant term. Additionally it is assumed that price p in the end market is equal to the costs of operators. The costs of operators consist on their part of costs for access charges and the rest costs. That is: $y(B;IS;TP) = A \cdot (\omega_1(IS;TP) + \omega_2(B;IS))^{\varepsilon}$, with ω_1: track access charges and ω_2: rest costs. Taken into account the maximal track supply for each investment possibility (given by the operating schedule), it is possible to calculate the constant term A:

$$A = \frac{y_0}{p_0^{\varepsilon}} \quad \text{with} \quad \begin{aligned} p_0 &= \omega_1(TP) + \omega_2(B) \\ &= \omega_1(TP) + \omega_1(TP) \cdot \left(\frac{\omega_{R.Tot}}{\omega_{R.1}} - 1\right). \\ &= \omega_1(TP) \cdot \frac{\omega_{R.Tot}}{\omega_{R.1}} \end{aligned}$$

The price p_0 is calculated from the actual track access charging system and the rest of operating costs. Additionally, an elasticity of -2.1 for the end market is assumed (see Baum, 1985). Since it is impossible to collect rest costs for all possible operators an additional assumption is made: The ratio of total costs to track access costs is equal for all operators. That is: $\frac{\omega_{Tot}}{\omega_1} = \frac{\omega_{R.Tot}}{\omega_{R.1}} = 6.7$. R in this formula denotes the Railion case and the value of 6.7 is calculated from the annual reports of Railion. The next step to the calculation of the constant term A is the calculation of operating costs, which are composed of time related costs, weight related costs and fixed operating costs. Fixed operating costs are identical for all operators and they are calculated from the maximum track supply (334 € per track). For the time related and weight related operating costs, the costs per minute respectively per tonne and kilometre are given by DB AG (See DB AG DS 226). As a result it is possible to calculate operating costs for each different investment possibility (times are given for each operating schedule and each investment possibility has a certain distance).

After calculating all cost components and the constant term A it is possible to calculate the demanded quantity by feeding the different track access charges regimes for each investment possibility and for each operating schedule.

Figure A-3 shows the changes in return on investment for operating schedule 115. The access charging system of 2003 (TPS 03) serves as a basis for comparison to the other two charging regimes used. Therefore the results shown in Figure A-3 represent the change of RoI compared to the charging situation of 2003. Independent from the charging regime it is clearly recognisable that the abatement of the slow speed point has always a positive RoI. All other alternatives have a negative RoI. This is hardly surprising since investment costs for this investment are the lowest compared to the other possibilities. Another result shown in Figure A-3 is that there are less considerable differences in RoI between the two-part tariff of 1998 and the relatively linear TPS 05. This is mostly due to the cost relatedness of the measure used.

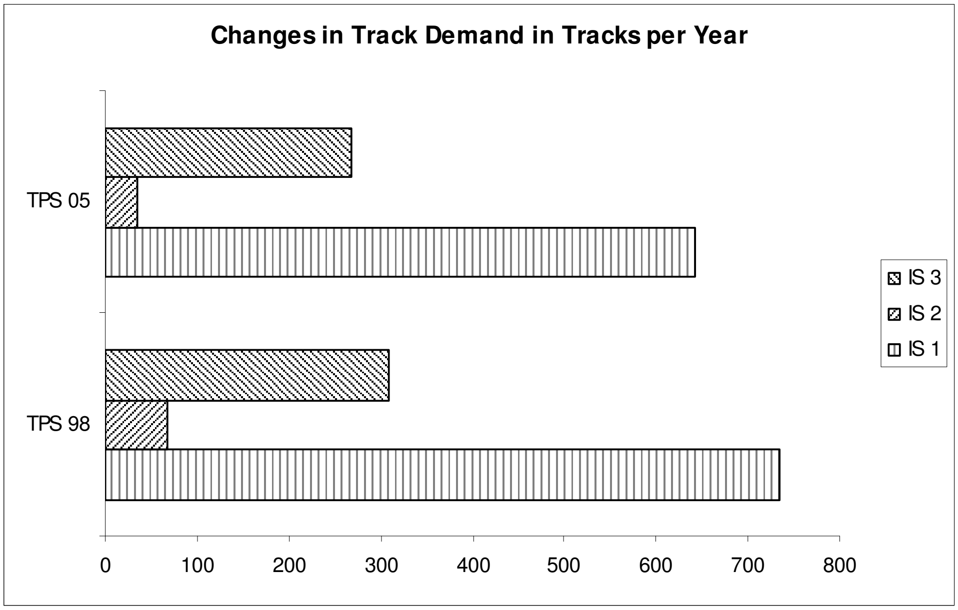


Source: Kunze (2006)

Figure A-3 Return on Investment for the Different Investment Possibilities

We continue with the demand development for the options calculated. Figure A-4 shows the changes in demand for tracks. As in Figure A-3, the results for both charging systems are compared to TPS 03.

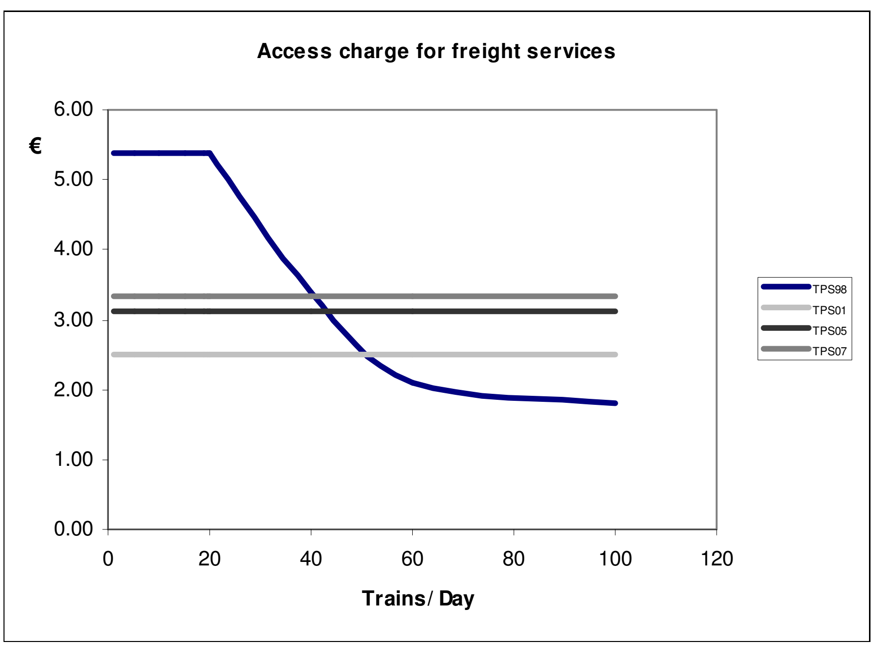
[15] The results for operating schedule 2 are very similar to the ones for operating schedule 1.



Source: Kunze (2006)

Figure A-4 Track Demand in Tracks per Year

One of the main findings is that the two-part tariff of 1998 tends to generate more transport activity than the currently effective uniform tariff. It is generally accepted that TPS 98 provided more incentives to firms to consume more. Taking into account the Willig theorem this is however not a surprise. A two part tariff (and therefore a differentiated tariff) can lead to welfare gains (compared with the current situation) as long as users are willing to pay the fixed charge component. Competition concerns (see Del. 7.1) led however to less differentiated uniform charge. DB competitors complained that due to the two-part tariff smaller firms could never have the chance to achieve a cost degression, and lobbied for an abolishment of this charging system. One possible interpretation is that indeed DB competitors' willingness to pay the fixed component of the charge was not high enough (see Figure A-5).



Source: Ewers & Ilgmann (2001), authors own calculations

Figure A- 5 Access Charges for Freight Services in Germany

Another possible interpretation has to do with the positive theory of infrastructure charges (see Del. 2.1 and Del. 3.1). Taking into account welfare losses coming out of lobby activities it is still possible, that the uniform tariff currently practised is superior from the welfare point of view. Since the change of the charging practice complaints decreased considerably[16]. This is a serious indicator that lobby activities decreased.

Figure A- 5 shows once more the development of access charges for a train under 1200 tonnes using F2 tracks (K3 for TPS 98). Here, it is recognizable that especially for Railion[17] the change of the structure of charges (from 1998 to 2001) is connected with substantial cost increases[18]. However, the decline in the output figures was around 15.8 percent. This would suggest an elasticity of around 0.4. However, such results should be seen very carefully, since there are far more factors affecting demand for railway infrastructure services. Some of these factors have been already named by the interviewed actors. Additionally, the low charging level as well as the nature of the goods transported must be considered. Therefore, in order to estimate correctly elasticities in the freight as well as in the passenger sector, econometric analysis is required.

16 There are some exemptions (see Del. 7.1), which however can be regarded as minor differentiation elements.

17 Railion operates more than 60 trains per day.

18 The charge increase for the reference train calculated was over 40 percent.