Centre on Regulation in Europe
Improving network and digital industries regulation

Track access charges: reconciling conflicting objectives

Case Study – Germany

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9 May 2018

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1. Introduction

Germany was amongst the pioneers in opening up the rail network for third parties against payment of infrastructure charges. Since 1994, both passenger and freight companies have open access to DB tracks. Since then, four fundamentally different track access charging schemes have been applied by DB Netz, the major provider of rail infrastructure in Germany. All of them have been based on the aim of full cost recovery and belong therefore to the highest in Europe. The charging schemes ranged from one-part pricing schemes (during 1994-1997 and 2001-2017) over a two-part scheme (1998-2000) up to a Ramsey-based charging scheme introduced in 2018. In addition, DB Station & Service, the provider of rail stations, levies charges for the use of stations within a meanwhile third version of a station charging scheme. According to DB's business reports, station charges contribute to around 20% of DB's total revenue from infrastructure charges (see table 1).

Apart from DB Netz, the by far largest provider of rail infrastructure in Germany, there are around 4000 km rail tracks in the ownership of other rail companies. Germany follows a symmetric approach of network access regulation, e.g. the open access rules refer to all companies possessing rail infrastructure, and all of them have to publish their access charging schemes. However, access charge regulation as outlined in the German Rail Regulation Law (EReG) distinguishes between infrastructure providers regarding their importance for a functioning rail market and foresees partial or full exemption from price-cap regulation.

This report focuses on the track access charging scheme of DB Netz which is in force since 2018. The charging schemes applied until 2018 are described elsewhere (see for example Link, 2017). Furthermore, the track access charging regimes of the 14 largest non-DB infrastructure providers, which operate in total about 2600 km of tracks, are reviewed regarding the underlying strategy of price differentiation.

Table 1: Profits[1)] of DB companies (profits before taxes and profit/loss transfers)

	DB Netz			DB Station & Service	
	Train-km (million)	Revenues from track charges (€ million)	Profit (€ million)	Revenues from station charges (€ million)	Profit (€ million)
2001	977	3193	-181	552	0.3
2002	964	3166	-548	544	-251
2003	981	3425	-324	573	37
2004	993	3638	-183	579	54
2005	989	3649	-260	599	69
2006	1006	3652	-212	624	52
2007	1038	3792	146	640	90
2008	1031	3883	338	661	190
2009	990	3887	768	681	150
2010	1020	4036	33	692	150
2011	1037	4145	307	715	155
2012	1025	4238	197	730	160
2013	1021	4307	66	740	169
2014	1030	4472	217	781	188
2015	1041	4554	81	807	203
2016	1054	4819	272[3)]	833	176[3)]

[1)] Profits before taxes and before profit-loss transfers within the DB Holding.

[3)] Profits after taxes and before profit-loss transfer.Taxation potentially changed due to the introduction of Bilanzrichtlinie-Umsetzungsgesetz in 2016.

Source: Business reports of DB companies.

2. Regulatory framework and track access charges

The major reason for introducing a new track access charging scheme was the need to respond to the requirements of EU Directive 2012/34 whose implementation into German law has been delayed. This delay was amongst other reasons caused by the long discussion and revision of the German Railway Regulation Law (ERegG) which was only adopted in 2016. The most important measures in this law are an incentive regulation for track access charges and a stronger rule of the regulator BNA (Bundesnetzagentur) which is now entitled to verify and permit access charges *ex-ante*. The *ex-ante* price cap regulation will be introduced in 2019 (start of the first regulation period 2019-2023). The current timetable period 2017/2018 is a transition period in which the regulator only verifies the appropriateness of costs including a profit margin, but does not set a price-cap. The ERegG defines the criteria (one of them being the importance of an infrastructure provider for a well-functioning rail market) which are relevant to introduce a full incentive regulation, a charge approval only, or an exemption from regulation. At the time of writing this paper, ten rail companies are subject to an incentive regulation. To these belong: DB Netz AG / DB RNI GmbH, UBB, DER, Regio Infra Nord-Ost, OHE, Emsländische Eisenbahn EEB, WLE, Hzl and Bayernbahn. About 100 companies are either fully exempted or subject to charge approval only.

The new track access charging scheme of DB Netz, valid since 2018, follows the requirements of EU Directive 2012/34 and the German Rail Regulation Law and consists of three broad elements for a set of defined market segments:

1. The direct (or marginal) cost of train operation;
2. Mark-ups for full cost recovery;
3. Reductions and surcharges to consider for example noise costs, time flexibility and priority requests etc.

The German Rail Regulation Law requires a separate treatment of long-distance rail passenger transport, regional rail passenger transport and rail freight as the minimum definition of market segments. According to §36 ERegG, mark-ups have to meet the following requirements:

- Passenger and freight transport have to cover their respective costs;
- Mark-ups must not preclude any market segment from track usage which is capable to recover at least its direct costs;
- The design and level of mark-ups have to guarantee the “best possible” competitiveness of market segments.

Furthermore, §37 ERegG states that the market segments for regional rail passenger transport services (RRPS) have to be defined as the area of federal states who are responsible for procuring and financing these services, based on governmental financial transfers (Regionaliserungsmittel). The Rail Regulation Law further requests that the track access charges to be paid for RRPS in each federal state are not allowed to exceed the average track access

charges in the respective state during the period 2016/2017. Track access charges have to increase with the same rate as the available regionalisation funds (currently 1.8% p.a., this compares to an access charge growth of 2.5% in the past). This implies that this rate is defined as an obligatory increase and not only as a price cap. Overall, the treatment of regional rail passenger transport leads in so far to a deviation from the (second-best) welfare optimal solution as these services are not charged a mark-up based on an (empirically) estimated price elasticity. Instead, the level of mark-up is defined to guarantee that track access charges in regional rail passenger services increase with the same rate as regionalisation funds. Whether this procedure leads to a higher or lower contribution of regional rail passenger services to the total costs of providing track access remains open in absence of detailed studies.

3. The track access charging scheme 2018

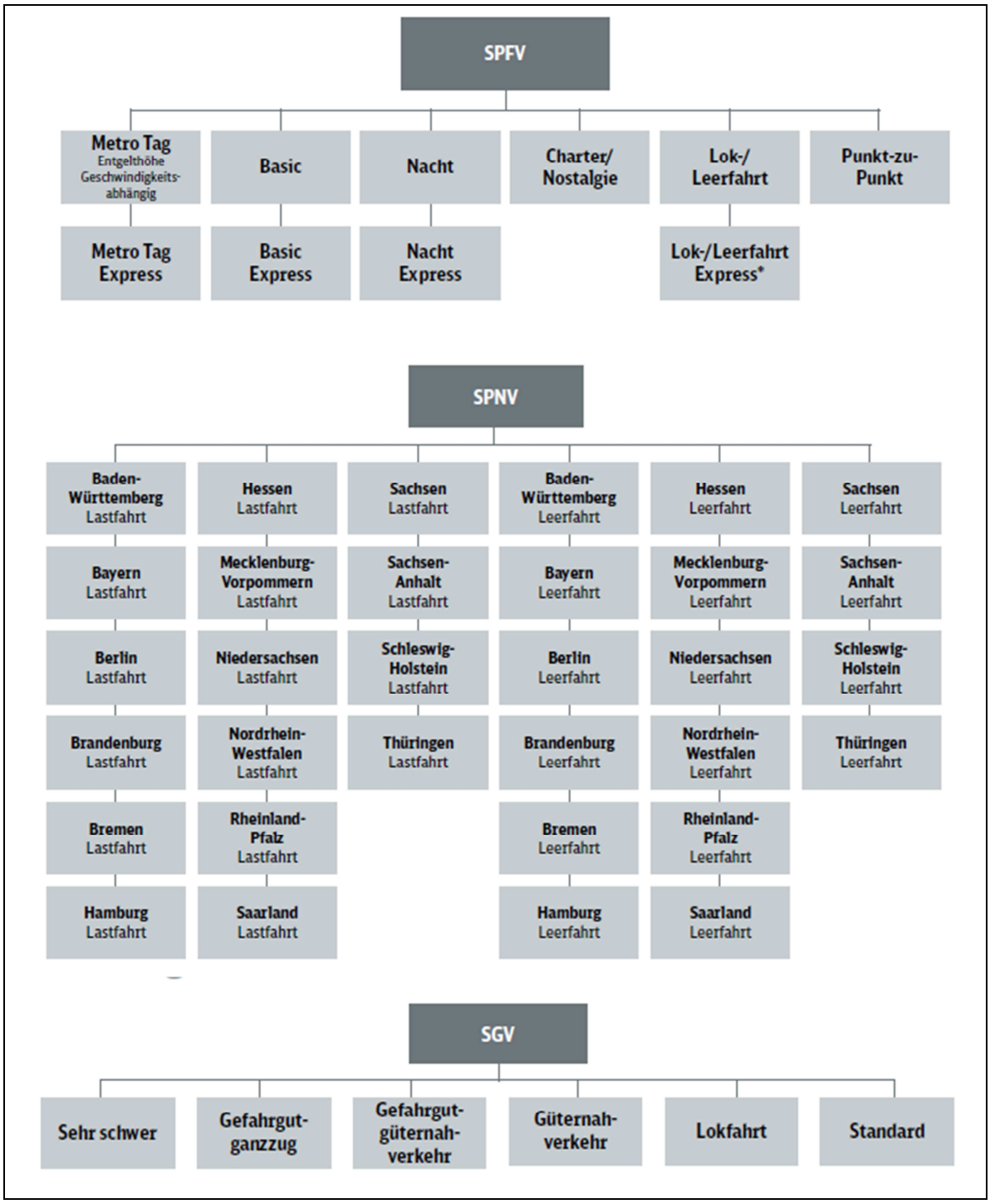
3.1 Market segmentation

In general, a sensible definition of market segments would be based on differences regarding the three main elements of the charging scheme, e.g. differences in the level of direct costs, differences in the demand curves leading to different price elasticities for quantifying the Ramsey mark-ups, and differences leading to reductions and surcharges. The ERegG suggests the following market segmentation for the purpose of access charging:

- Passenger vs. freight transport;
- dangerous goods transport vs other transport;
- domestic vs cross-border transport;
- combined vs direct transport;
- regional vs long-distance passenger transport;
- block train vs single wagon transport;
- regular vs ad hoc transports.

The segmentation introduced by DB Netz follows the requirements of the ERegG with three exceptions: there is no distinction between domestic vs cross-border transport which are assumed to have an identical structure of demand and cost. Furthermore, there is no distinction between combined vs direct transport and between regular and ad-hoc timetable transport for which according to DB Netz cost differentials seem to be not observable. The regulator has verified the appropriateness of the market segments regarding their price sensitivity and has requested that for dangerous goods transports a further distinction between regional (below 75 km transport distance) and others has to be introduced.

Figure 1: Market segments in the track access charging scheme of DB Netz 2018



Legend: SPFV: Long-distance rail passenger transport; SPNV: Regional rail passenger transport; SGV: Rail freight, here further segmentation into "Fast" (priority over other freight trains and "Express" (priority over all other trains except high-priority passenger trains).

Table 2: Market segmentation for long-distance passenger transport and freight

Segmentation criterion	Segments and definition	Theoretically assumed differences in		Differences in track charges	
		Direct Costs	Demand	Direct Costs	Demand
Long-distance passenger transport					
Relation	Metro[a)] Other	Higher wear & tear and maintenance standards	√	No	√
Time of day	Day: 6:00 - 20.00 Basic: 20:00 – 23:00 Night: 23.00 – 06:00	Low Staff costs (night shifts)	√	No	√[b)]
Speed	More than 160 km/h 100 – 160 km/h Up to 100 km/h	Wear & tear	√	No	√[c)]
Time flexibility for point-to-point	No flexibility ±30 min	No	√	No	√
Connectivity	Point-to-Point traffic[d)] Other	No	√	No	√
Frequency	Up to 4 trains/day, More than 4 trains/day	No	√	No	√
Prioritisation	Priority No priority	No	√	No	√
Nostalgic trains		No	√	Lower charge	√

Segmentation criterion	Segments and definition	Theoretically assumed differences in		Differences in track charges	
		Direct Costs	Demand	Direct Costs	Demand
Rail freight					
Weight	Heavy (>3000t) Standard	Wear & tear	√	Yes	√
Type of goods	Dangerous goods Other	Higher safety costs	√	No	√
Train length	Block train (up to 370m) Train with single waggons	Lower wear & tear for trains with lower length	√	Yes[e)]	Yes[e)]
Flexibility	Route flexibility: Yes/no Time flexibility: Low=±30 min High ±120 min	No	√	No	√
Prioritisation	No priority Fast[f)] Express[g)]	No	√	No	√
Relation	Regional (<75 km)[h)] Others	No	√		√
Loco and empty runs		Yes (lower wear & tear)	No	Lower	√

Notes: a) Refers to trains connecting so-called Metropolitan stations (defined as 44 with more than 50,000 travellers per day and 8 border stations with >5,250 trains/day, both RRPS and long-distance passengers. b) Equal mark-up for Basic and Night Express.- c) Linear increase of access charge between 100 km/h and 160 km/h.- d) Less than 3 connections.- e) Block train with dangerous goods in charging scheme defined. Local trains with dangerous goods are charged lower direct costs and a lower mark-up than other dangerous goods trains. - f) Priority over other freight trains.– g) Priority over all other trains except High-priority passenger trains.- h) Restricted to trains below 3000t and below 370m length.

Source: DB Netz (2017), own analysis.

Figure 1 gives an overview on the market segments. Table 2 compares for these market segments the theoretically expected differences regarding direct costs and price elasticities of demand with the differentiation realised in the track access charging scheme 2018 of DB Netz. Since for RRPS market segments are defined artificially as the area of the federal states table 1 is restricted to long-distance passenger transport and rail freight. Apparently, the theoretically expected different levels of direct (marginal) costs is for most segments not reflected in the charging scheme while mark-ups follow closer the expected differences in demand. Market segmentation and differentiation of charges were obviously rather derived under the aspect of Ramsey mark-ups than under the aspect of cost causation. One can argue that differentiation of marginal costs is only sensible if significant cost differences between segments can be expected. In absence of empirical material it cannot be analysed to what extent this would be the case. It should also be taken into account that track users have an interest in not too complex charging schemes, and therefore a compromise between a theoretically desirable degree of

differentiation and a practicable one has to be found. A more detailed discussion is given in sections 3.3 and 3.4.

3.2 The approved level of total costs

3.2.1 Definition of eligible costs

The ERegG defines the eligible costs as all costs which occur for providing the minimum track access package. These comprise expenses for staff, material, others and the book depreciation (at purchase cost basis) for the minimum access package minus revenues other than from track access charges, and further revenues plus a market-based profit. This regulatory definition is based on the components of the profit-loss statements within the Commercial Code. State subsidies and grants have to be subtracted in accordance with the requirements of the EU Directive. This issue concerns both federal subsidies within the so-called LuFV (*Leistungs- und Finanzierungsvereinbarung)*, a contractual agreement between the Federal government and DB to finance repair and replacement of the track network, and the public financing of new construction and enlargement.

3.2.2 The capital cost issue for a 100% state owned company

The ERegG defines a market-based rate of return on capital as part of the eligible costs. The definition of this rate of return was heavily disputed between the regulator, DB Netz and within the scientific and consultancy community. Since most of the quantitative information is not publicly available; the following summarises the arguments and gives, as far as possible, figures.

Both the regulator and DB Netz have used the WACC (weighted average cost of capital) method to derive the capital cost chargeable within the track access charging scheme. The WACC is the commonly used instrument for publicly traded companies which considers the ratio between own and external finance of the company. There were two major points of discussion in the procedure of access charge approval. First, it was questioned whether the application of WACC to DB Netz is appropriate due to its 100% public ownership and the fact that any privatisation of DB Netz is not permitted due to the German constitution. Furthermore, the Federal Government finances investments for infrastructure and about two thirds of track charge revenues come from the federal states via the regionalisation funds, i.e. via state money. The second point of critique refers to the parameters used for the WACC method. Arguments were raised that interest rates, risk premiums, tax rates etc. used by DB Netz were not appropriate.

DB Netz has applied for approval of an interest rate before taxes of 7.5% and justifies this with a company-internal goal of a 7.5 % ROCE. Details of the derivation of this rate (e.g. shares of own and external capital, risk-free interest rate, risk premium for own capital, beta-value etc.) are not publicly available, however, DB Netz provides in its business report a rate of return of capital of 6.7%.

The regulator has finally approved a WACC of 5.9% for the regulation period 2019-2023, differentiated by own capital interest rate of 9.5% and external capital interest rate of 3.2%.[1] Balks (2017) suggests two alternative calculations based on a response to the regulation procedure on behalf of *Netzwerk Europäischer Bahnen* (Balks and Böttger, 2017, not public). They obtain an interest rate of 1.62% under the assumption of equal rates of returns of own and external capital without risk premium, and a figure of 3.18% with the WACC method with parameters which differ from the calculations of DB Netz and the regulator.

The issue of capital costs will not be described in more detail here, since most information is not publicly available, and due to the fact that this is a field of expertise in itself and would require a separate paper. The interested reader is referred to the reports of FRONTIER and IGES (see FRONTIER and IGES, 2009, 2013, 2016) prepared on behalf of BNA, the NERA study commissioned by DB, and the recent paper of Balks (Balks, 2017) which is based on a study for the *Netzwerk Europäischer Bahnen*.

3.2.3 Level of total eligible costs, direct costs and mark-ups

The approved level of costs chargeable for the minimum package of track access was set to €5,084 mill. for 2018 and to €5,307 for 2019-2023. The price cap for 2019 has been defined as €5,299 mill. At the time of writing this paper, the price cap for 2020-2023 has not yet been defined.

Table 3: Level of costs eligible to be charged within the track access charging scheme of DB Netz

	2018			**2019-2023**	
	Revenues from access charges (million €)	**Costs of the minimum access package (million €)**	**Train-km (million)**	**Base level of eligible costs (million €)**	**Train-km (million)**
Applied for approval	5,084	5,613		6,086	1,052
Approved	5,084[a)]	5,237[b)]	1,065[c)]	5,307	1,052
Notes: a) According to BNA 2017a, p. 39, the eligible range of revenues is as follows: lower bound = €4,636 mill. (without capital costs) and upper bound = €5,237 mill. (with capital costs according to alternative 1). b) BNA 2017a, p. 39. c) BNA 2017a, p. 40.					

Sources: for 2018 BNA 2017a, for 2019-2023 BNA 2017b.

The regulator has also analysed the derivation of direct costs and mark-ups. The decisions of the regulator (BNA 2017a,b) do not allow a full re-calculation and verification of all relevant components. However, Table 4 contains the calculation of the author based on quantitative information in BNA (2017a) which was supplemented by other data owned by the author in particular for RRPS. Overall, the calculation shows that about 20% of total costs have been

[1] The regulator has used the following parameters: share of external capital = 64%, risk-free interest rate = 2.6%, risk premium = 3.8%, beta = 1.07 (see BNA, 2017b).

identified as direct costs. Two thirds of total costs are charged to RRPS, 20% to long-distance passenger transport and 14% to freight transport. It should be noted, that in absence of suitable data, the calculation did not take into account the lower charges for empty runs. Therefore, the charges to be paid by RRPS are to some extent overestimated and those paid by long-distance passenger transport underestimated.

Table 4: Direct costs and mark-ups for long-distance and regional rail passenger transport and rail freight for the period 2017/2018

	Direct cost (million €)	Mark-up (million €)	Total (million €)	Charge (€/Train-km)
Long-distance passenger transport	162	856	1018	6.6
Regional passenger transport	436[a)]	2864[a)]	3300	5.16
Freight transport	332	397	729	2.77
Total	929	4117	5084	4.78

Notes: a) Figures are obtained by allocating the total revenues of €3,337.4 mill. for RRPS (source: BNA 2017a, table 61, p. 106) between direct costs and mark-ups as following: Direct costs are calculated by using the charge per train-km for RRPS (with passengers, empty runs not considered) in each federal state with train-km. An analogous calculation was performed with the mark-ups per train-km. This procedure yields total revenue of €3,300 mill.

Sources: BNA 2017a, p. 106 Table 61. Figures for regional rail passenger transport: own calculations.

3.3 Derivation of direct (marginal) costs

DB Netz defines the following elements as direct costs which vary (at least partly) with transport volume:

- Time tabling costs;
- Operation costs;
- Ongoing track maintenance;
- Ongoing maintenance at tracks which are recorded within operation costs;
- Track depreciation as defined by the legally accountable life-times of asset (book depreciation).

Not included are interests on capital, common costs of the DB Holding allocated to DB companies (the so-called *Konzernumlage*), administration and distribution costs and some costs which are not included in the track cost accounting system of DB Netz but do occur in relation to tracks. Track depreciation is defined on a gross base, i.e. does include construction subsidies. However, in the overall level of eligible costs, state subsidies are eliminated. Other operating income and non-operating income factored in are subtracted. The time horizon considered for quantifying the cost share which varies with changes in traffic volume is one year. An exception which was criticised by the regulator is the staff cost at signal boxes which is defined as the personnel above a minimum staff number. For this item, a time horizon of less than one year was chosen. The direct cost given in Table 4 is based on average costs for 2013-2015. Based on quantitative information in BNA (2017a) and on additional information provided by DB Netz, it

can be concluded that about one quarter of direct costs are depreciation costs and 58% are maintenance costs (see Table 5).

Table 5: Components of costs which are defined as relevant for deriving DC (MC)

Cost component	€/train-km	Total (€ million)	Method of estimation	Cost share depending on traffic volume	Allocation factor (Cost driver) for segments
Time tabling costs • Staff costs • Costs for new workplaces	0.044**	42	Expert estimates	100%	Number of track access applications
Operating costs • Staff costs in signal boxes • Staff costs for level crossing operation • Staff costs in control centres	0.114	122	Expert estimates	All operation staff above the minimum staff number required, share not published	Train-km
Costs of ongoing maintenance • Clearance of faults • Other individual maintenance measures • Repair of tracks • Repair of sleepers • Mud removal • Repair of switches • Repair at other facilities other than tracks	0.286*	304	Expert estimates	See Table 5	See Table 5
Other maintenance	0.013**	14	n.a.	n.a.	n.a.
Maintenance of operating nodes	0.210**	218	n.a.	n.a.	n.a.
Depreciation of tracks[1)] Book depreciation (linear depreciation over the legally defined life-times of assets)	0.205**	230	Regression analysis	Not published	Train-km
Notes: *) This amounts to 80% of all maintenance expenditures for assets of DB Netz.- **) Based on a telephone conversation with DB Netz. - 1) Gross depreciation on total investments incl. renewals, new construction and enlargements, construction subsidies not subtracted here. Excluding bridges and tunnels, assets included are tracks and sleepers.					

Sources: DB Netz 2017, Figures taken from BNA 2017a, pp. 100-102, partly own calculations. Calculations exclude the component 'other maintenance' for which no information is available.

Table 6 summarises information given in DB Netz (2017) for types of maintenance measures. The derivation of variable versus fixed costs as well as the definition of cost drivers and their weight in allocating costs to types of transport is based on expert estimates and not further detailed. The by far most frequently mentioned cost driver with a high share in variable cost allocation is train weight.

Table 6: Cost responsiveness and cost drivers of direct costs - maintenance

Measure	Cost share		Cost drivers and their share in variable costs		
	Varying with traffic volume	Fixed	Number of trains	Weight of trains	Speed
Clearance of faults	95%	5%	80%	0%	20%
Other individual maintenance measures	80%	20% (due to regular intervals)	33.3%	33.3%	33.3%
Repair of tracks	80%	20% (age, weather, track quality)	0%	50%	50%
Repair of sleepers	50%	50% (age)	0%	100%	0%
Mud removal	15%	85%	20%	80%	0%
Repair of switches	80%	20% (age, weather)	0%	80%	20%
Repair at other facilities other than tracks	80%	20% (age, weather, track quality)	0%	50%	50%

Source: DB Netz 2017.

While the usage-dependency of time tabling costs, ongoing maintenance costs and operation costs are intuitively plausible, the treatment of depreciation cost as measured by the German *Afa*-values (book depreciation) seems to be disputable. Under the assumption that the Afa-values do reflect the amount of renewals spent, they might serve as a proxy in absence of data on renewals over a longer time period. The problem, however, is that the Afa-values (which are calculated linearly over the legally defined lifetime of assets) reflect average technical wear & tear and economic obsolescence of assets, but mirror differences in wear and tear due to intensity of usage and load only indirectly.

There is no description of the estimated functional relationship, the variables considered and the estimation results including significance levels etc. publicly available[2]. DB Netz (2017) shows only a text-book graph to illustrate the approach (see Figure 2). According to additional information provided by DB Netz[3], a linear regression model without transformations (logs, or Box-Cox transformations) was estimated, including train-km by long-distance and regional passenger transport as well as freight as separate explanatory variables, together with control variables such as single versus multi-tracks and number of sleepers. The Afa-values used refer to all investments, i.e. renewals, new investment and enlargements. The estimates reflect therefore long-run marginal costs rather than short-run. It should also be noted that the Afa-values include state subsidies implying that direct costs seem to include state subsidies of an unknown amount.[4] A feasible argument for this is that marginal costs should reflect the costs

[2] The regulator has access to this information.
[3] Telephone conversation from 21 March 2018.
[4] The regulator has knowledge of this amount, however, this information is not public.

occurred independently of who pays for them. Furthermore, this procedure is comparable to estimates derived from engineering approaches which also derive the cost occurred independently of the source of financing.

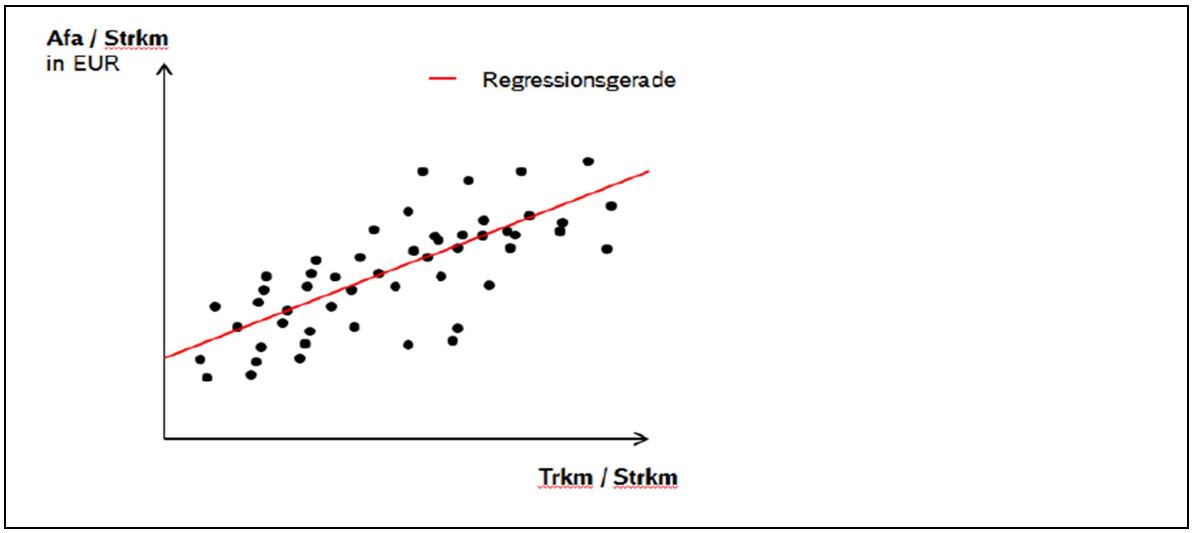
Since neither the data are available, nor descriptive statistics and estimated coefficients are given, it is hard to evaluate the approach[5]. Presumably, DB Netz did not use an approach of regressing expenditures for repair and renewal against the load carried over the sections (e.g. measured by gross-tone km) due to insufficient data, either too short time horizons for renewal data or unreliable data on train weights. This needs to be clarified for the future since in principle such data have to be recorded within the multi-annual contract(s) closed since 2009 between the Federal government and DB on infrastructure financing.

A second issue is the reflection of weight-dependent costs in the direct cost as charged within the track access charging 2018 (see Table 7). The expert estimates mentioned in DB Netz (2017) allocate for maintenance measures except for clearance of faults considerable shares of cost causation due to the weight of trains. This is in line with discussions amongst experts at the EU level (see for example Link and Maibach, 1999) and with econometric evidence for France, the UK and Sweden. The same holds true for the importance of train weights for wear and tear which impacts on the level of repair and renewal costs. However, train weight as a cost driver is only to a very low extent reflected in the direct costs charged within the track access charges. For freight trains, there is only a weight-related distinction between standard and heavy freight trains (above 3000t). In long-distance passenger transport, no weight-related differentiation is introduced at all. DB Netz explains the lack of more weight differentiation in access charges with difficulties in recording the actual train weights properly. While track applications by TOCs contain information on the train weight it is not possible to verify with which weights trains were finally run.

A third issue refers to the influence of higher speeds on maintenance and renewals of tracks, which are currently not considered in access charges.

[5] According to information from the regulator, DB Netz has performed a more detailed regression analysis, for example with including maintenance as an explanatory variable and with train-km differentiated by regional, long-distance and freight trains (where, for the latter, an issue of multicollinearity could have occurred). Details are not public and can thus not be verified.

Figure 2: Scatterplot book depreciation per track-km versus train-km per track-km



Source: DB Netz (2017).

Table 7: Direct costs charged within the track access charging scheme of DB Netz 2018

Market segment	Direct cost (€/train-km)	Time tabling cost (€/train-km)[1)]
Long-distance passenger transport		
Metro, day[1)], >160 km/h	1.145	0.01
Metro, day, [1)] 100 - 160 km/h	1.145	0.01
Metro, day[1)], <100 km/h	1.145	0.01
Basic[2)]	1.145	0.01
Night[3)]	1.145	0.01
Nostalgic trains	0.666	0.03
Point-to-point[4)]	1.145	0.01
Loco/empty runs	0.627	0.06
Regional rail passenger transport		
With passengers	0.666	0.03
Loco/empty runs	0.627	0.06
Rail freight		
Standard[5)]	1.315	0.10
Heavy (>3000t)	2.337	0.10
Regional freight train[6)]	0.818	0.10
Dangerous goods train –regional	0.818	0.10
Dangerous goods train >75 km distance	1.315	0.10
Locomotive runs	0.627	0.10

1) Time tabling costs based on non-public information of DB Netz which differs for some categories from information in DB Netz (2017) where time tabling costs in the framework of cancellation charges are reported.

Source: DB Netz (2017), as of February 2017.

Overall, there is only little differentiation of direct costs charged (see Table 7). The level of 1.145 €/per train-km is equally charged for all long-distance passenger trains except for nostalgic trains and for locomotive and empty runs. Direct costs of RRPS trains are set under the

constraint of not exceeding average access charges paid in 2016/2017. The charge of 0.666 €/train-km is around 58% of those for long-distance passenger trains (which include high-speed trains, IC/EC trains and conventional trains). A standard freight train is charged a direct cost of 1.315 €/train-km, e.g. 15% higher than a long-distance passenger train. The only weight differentiation is applied for a heavy freight train which is charged a three-quarters higher direct cost than a standard freight train. Regional freight trains (up to 75 km distance) are charged only about two thirds of a standard freight train which may run over the same sections.

3.4 Derivation of mark-ups for full cost recovery

The track access charging scheme 2018 uses Ramsey prices to derive mark-ups for full cost recovery, i.e. mark-ups follow the rule

$$\frac{p_i - \frac{\partial C}{x_i}}{p_i} = \frac{\gamma}{|\varepsilon_i|} \qquad (1)$$

where **p** is the track access charge, $\boldsymbol{\partial C/x}$ denotes the marginal cost occurring for track demand **x** and **γ** is **λ/(1+λ)** with the Lagrange multiplier **λ**. This rule is also known as rule of inverse price elasticities. However, it should be noted that in its above form, it assumes that all cross-price elasticities are zero, i.e. demand is independent from price changes of other products. Furthermore, the marginal cost in the above equation has to be evaluated not at the level of marginal cost prices but at the level of Ramsey prices – an important issue when the marginal cost function is non-linear.

There is – at least for Germany – no econometric study on the cost responsiveness of track demand on changes in access charges available. However, within the Federal Masterplan on Infrastructure Development 2030 (BMVI, 2015), the transport ministry has for the first time commissioned studies on the value of time for both passenger and freight transport. Both studies use RP/SP surveys and estimate discrete choice models which can be used to derive estimates for price elasticities of final demand for rail passenger and freight transport. In addition, DB Netz has commissioned studies to derive elasticities for regional freight and dangerous goods transports (not public, prepared by "Produkt und Markt"). The issue is then how these price elasticities of final demand can be transferred into track charge elasticities.

DB Netz assumes that final demand, i.e. passenger and freight demand, respond to a change of track access charges with an identical change of final demand for rail services, i.e. the response rate is 100%. Under this assumption, the track charge elasticity **ε** can be formulated as the product of the price elasticity of final demand for rail passenger and freight transport and the share ***s*** of track access charges at the turnover ***w***

$$\varepsilon_i = \frac{p_i}{w_i}\ \varepsilon_i^{final} \qquad (2)$$

Rearranging (2) and inserting into (1) gives

$$\varepsilon_i = \frac{\partial C}{x_i} + \gamma \frac{w_i}{\varepsilon_i^{final}} \quad (3)$$

DB Netz uses a lambda (which refers to **γ= λ/(1+λ)** in this paper) of 0.1011.

This general approach has been approved by the regulator with the exception of freight transport where DB Netz had to revise the mark-ups (see below). It should be noted that the mark-ups for RRPS in Table 8 do not result from econometric elasticity estimates. They are given by the constraint set in the ERegG (charge increase restricted to a maximum increase defined by the increase of regionalisation funds).

Table 8: Mark-ups by market segment

Market segment	Direct price elasticity of end user (ε^{final})	Turnover (w) (€/train-km)[a)]	Mark-up (€/train-km)
Long-distance passenger transport			
Metro, day, >160 km/h	-0.435	45.09	10.485
Metro, day, 100 - 160 km/h			4.035-10.375
Metro, day, <100 km/h	-0.528	20.48	3.925
Basic	-0.559	18.62	3.365
Night	-0.609	8.19	1.365
Nostalgic trains	-0.661	9.03	1.384
Point-to-point	-0.642	18.62	2.935
Locomotive/empty runs	n.a.	n.a.	1.423
Regional rail passenger transport			
With passengers	n.a.	n.a.	4.112-4.865
Locomotive/empty runs	n.a.	n.a.	2.257-2.893
Rail freight			
Standard	-1.500 (-0.189)[b)]	20.30	1.515
Heavy (>3000t)	-1.320 (-0.239) [b)]	20.30	1.713
Regional freight train	-1.861 (-0.198) [b)]	15.66*	0.852
Dangerous goods train – regional	-1.49 [b)]	n.a.[c)]	1.062
Dangerous goods train >75 km distance	-1.056 (-0.163) [b)]	n.a.[c)]	2.145
Locomotive runs	-	-	1.043

Notes: a) DB Netz (2017), English version, p.35.- b) Figures in brackets refer to the track charge elasticity estimated by BNA (BNA, 2017a).- c) DB Netz (2017) gives an overall turnover for dangerous goods transports of 20.30 €/train-km.

Source: DB Netz (2017), BNA (2017a). Elasticity figures are those after the decision of BNA (see BNA 2017a).

For long-distance passenger transport DB Netz uses elasticity estimates for three segments, which are business travellers, commuters and leisure time travellers. These elasticity estimates are combined with the share of these segments per types of trains and the share of track access charges in turnover for types of trains. DB Netz uses an average turnover of €0.103 per passenger-km which can be derived from the profit-loss statement in the business report *of DB Fernverkehr*[6]. Related to train-km this makes an average of 28.27 €/train-km. Differentiated figures for each market segment within long-distance passenger transport are based on internal data and range of €45.09 for trains above 160 km/h and €20.48 for trains below 100 km/h between metropolitan stations during day time. These internal figures are not publicly available, neither those on train-km nor on turnover for market segments.

The average turnover of rail freight on DB tracks is based on figures of the rail regulator who surveys annually the rail market. For 2014, BNA (2015) reports an average turnover of €19.90 per train-km.[7] It has to be taken into account that this is a figure derived from the available responses of the rail companies surveyed, i.e. not a projected figure. The track access charging scheme 2018 assumes equal turnover/train-km figures for both standard and heavy trains as well as for dangerous goods trains. For regional freight trains (below a transport distance of 75 km) a lower turnover was assumed (but not quantitatively reported).

The regulator has not approved the assumed elasticity and mark-up for standard freight trains and has requested to differentiate between regional and other dangerous goods trains. The major argument for requesting a revision of the elasticity for standard freight trains were the elasticity estimates given in BVU et al. (2016) which are based on a discrete choice model estimated by using data from RP/SP surveys (see Table 9), in contrast to DB Netz who assumed an elasticity of -1.32 for both combined and conventional trains. The regulator has derived an elasticity of -1.5 for standard trains and -1.32 for heavy trains. Furthermore, two elasticity figures for regional and other dangerous goods trains were defined in contrast to an overall elasticity of -1.056 originally derived by DB Netz, based on the aforementioned (not public) study of *Produkt und Markt*. The major argument of the regulator was that this study did not survey dangerous goods transports at shorter distances. BNA has therefore approved the figure of -1.056 only for distances above 75km.

Finally, it has to be mentioned that the regulator has commissioned a study on price elasticities for all relevant market segments in both rail passenger and rail freight transport. This study is, at the time of writing this paper, still ongoing.

[6] The business report gives for 2015 the following figures: Turnover=€3,912 mill., passenger-km=35 bill. This gives an average of 0.105 €/passenger-km.
[7] The subsequent market studies of BNA report for 2015 a turnover of €20 per train-km and for 2016 a figure of €21.6 per train-km.

Table 9: Price elasticity estimates of rail freight by market segments from BVU et al. (2016)

Market segment	BVU et al. (2016)
Combined transport – maritime	-1.393
Combined transport – continental	-1.301
Trains >100t lot size*	-4.245
Food	-2.350
Pit and quarry	-2.770
Mineral oil products	-1.894
Chemicals, fertiliser	-2.475
Metals	-1.592
Vehicles, machines	-1.513
Other products	-1.550
Notes: *) BVU et al. (2016) failed to estimate a model for the segment coal, coke and ore due to a too small sample size. They suggest to use the model for the segment of transports with lot size > 100t instead.	

Source: BVU et al. (2016).

3.5 Surcharges for priority requests and flexibility

The charging scheme contains surcharges for priority requests and for flexibility as following. Long-distance passenger trains (except nostalgic trains, point-to-point traffic and locomotive and empty runs) with high priority ("Express") have to pay a surcharge of €2 /train-km. For freight trains, a similar operation characteristic can be chosen by the train operator. The charging scheme distinguishes between the segments "Express" and "Fast" which can be applied to all freight trains except those allocated to the segment "Very heavy" and "Locomotive run". For "Express", a surcharge of €2 /train-km and for "Fast" a surcharge of €0.50 /train-km is levied. Furthermore, temporal and geographical flexibility of train paths is taken into account by a charge reduction of €0.10 /train-km for temporal flexibility (±120 min) as well as for geographical flexibility.

3.6 Further elements of the charging scheme

The track access charging scheme 2018 contains further surcharges and reductions which will not comprehensively be reviewed here. The most important ones are:

1. **Noise charges**

   Since 2013, the track access charges contains a bonus-malus scheme where noisy freight trains have to pay a surcharge of 4% on the access charge, and trains equipped with noise-reducing brakes receive a bonus of 0.5 Cent per axle-km. This noise differentiation of charges is not allowed to change the overall level of revenues from track access charges. Revenues from malus payments are used to subsidise TOCs to equip wagons with noise-reducing brakes. The noise bonus-malus scheme will not be further discussed in this paper.

2. **Cancellation charges**

   DB Netz has applied for approval of two types of penalties regarding cancellation of train paths, both justified with the need to incentivise an efficient use of track capacity. A first type of cancellation penalty was intended to be raised if using an allocated train path was delayed by more than 20 hours (so-called 20 hours rule). It was planned that both the originally allocated train path and the new train path were charged, the first with 80% and the latter with 100% of the full charge level. Second, DB Netz intended to charge a minimum cancellation fee per day. The level of this fee is based on direct costs and was derived by multiplying time tabling costs with train-km for cancellations up to 30 days beforehand, with increasing %ages of the full charge, depending on the time horizon (between 15% and 80% of the access charge minus the direct cost).

   The regulator has refused approval and decided for a revision of the 20 hours rule while the cancellation charge was approved with the exception of a defined cap for cancellations up to 30 days before departure. One of the major arguments was that DB Netz was not able to prove shortage of capacity since the overwhelming share of track access applications could be met, eventually with somewhat differing time windows (see BNA, 2017a, p.140). A further argument in refusing the so-called 20 hours rule was that incentives are only sensible if track users can respond by changes in behaviour. However, postponements and delays in using a train path are usually caused by the clients of TOCs and cannot be influenced by TOCs.

3. **Penalties for train delays**

   DB Netz has originally intended to charge for delays of more than 6 minutes in passenger transport and more than 31 minutes in freight transport an amount of 10 Cents per minute, to be paid by TOCs and DB Netz depending on causation of delays. The regulator has refused the whole scheme for several reasons, amongst them the fact that the S-Bahn systems in Berlin and Hamburg were exempted, and because there were no differentiation between time table transports and ad-hoc transports (which have more delays). The most important reason, however, was that the penalty of 10 Cents per minute was too low to give an incentive to avoid delays, given that it is

cheaper to pay the penalty than to settle the causes for delays. DB Netz is currently in the process of elaborating a new penalty scheme.

4. Track access charging schemes of non-DB companies

Table 10 provides an overview on the track access charging schemes of the 14 largest rail infrastructure providers after DB Netz. They operate in total a track length of 2670 km, i.e. more than half of the non-DB network.[8] Most of them differentiate access charges by passenger and freight trains and by type of track, and the majority takes also train weight into account. Furthermore, penalties for delays are common as well as cancellation charges. It should be noted, that Table 10 summarises only the most important pricing criteria and does not aim to give a full overview on each of the 14 charging schemes.

The average access charges range for passenger trains from €1.1 to 19.8 /train-km and for freight trains from €2.8 to 32.5 /train-km. Passenger trains are either charged equally with freight trains or pay higher charges than freight trains. Compared to figures from the market survey of the regulator (see BNA 2017c), access charges of surveyed companies ranged in 2016 from a minimum of €0.01 /train-km to a maximum of €144.6 /train-km, with a median of 4.71 and a mean of €4.57 /train-km. A direct comparison with the figures in Table 10 is not possible since BNA 2017c does not provide information on response rates and their coverage of the market, but apparently, the figures given in Table 10 fit into this range.

[8] According to BNA, out of these the following companies are subject to an incentive regulation: Deutsche Regionaleisenbahn, RegioInfra Gesellschaft, Osthannoversche Eisenbahn, Hohenzollerische Eisenbahn, Westfälische Landesbahn, Bayernbahn.

Table 10: Track access charges of the ten largest non-DB rail infrastructure providers

				Charge differentiation by:			Factor for:		Surcharges and penalties for:			Average access charge (€/train-km):	
Company	Track length	No. of employees	Turnover (€ million)	Passenger vs. freight trains	Type of track	Weight of train	regularity of transport	empty runs	delays	Cancellations	short-term access applications	Passenger trains	Freight
Deutsche Regionaleisenbahn	387	29	1.7		√	√					√	7	7
RegioInfra Gesellschaft	375	n.a.	4.7	√	√	√	√	√			√	3.9	3.5
Albtal-Verkehrs-Gesellschaft	264	833	198	√	√					√		4.5	3[b]
Eisenbahnen und Verkehrsbetriebe Elbe-Weser	261	380	80	√	√				√			4.05 [c]	4.05[c]
Osthannoversche Eisenbahnen	291	1 564	11.8	√					√	√	√[a]	n.a.	n.a.
Rhein-Sieg-Eisenbahn	225	8	1.2	√	√							3.3	6.4
Hohenzollerische Landesbahn	123	276	43.8	√	√					√	√[a]	6.4	4.6
AKN Eisenbahn	97	280	19.1	√	√					√	√[a]	5.3	5.2
Thüringer Eisenbahn	116	24	n.a.	√	√	√		√				5.9-6.6	2.8-3.9
Westfälische Landes-Eisenbahn	119	112	14	√					√			7	32.5
BayernBahn Betriebsgesellschaft mbH	108	n.a.	n.a.			√	√			√		7	7
LWS Lappwaldbahn Service GmbH	102	n.a.	n.a.	√		√				√		1.1	3.8
Rurtalbahn GmbH	102	97	13			√	√	√		√		4	4
Teutoburger Wald Eisenbahn GmbH	103	n.a.	n.a.		√				√	√		19.79	19.79

Notes: a) Includes also a charge for changes of an already contractually agreed train path. b) Refers to standard price for trains with low flexibility.- c) Price for passenger trains and regional freight trains.

Source: Own analysis based on published access charging schemes.

5. Conclusions

After four charging schemes ranging from a one-part scheme (1994-1997) over a non-linear two-part tariff scheme with self-selection (1998-2000) back to a one-part scheme (2001-2017), the track access charging 2018 introduces a fundamental change of the charging paradigm. In contrast to previous schemes, the track access charging scheme has with the direct cost component a close link to marginal cost pricing. Under the constraint of full cost recovery, the Ramsey prices provide the (second-best) welfare optimal approach. However, the treatment of regional rail passenger transport leads in so far to a deviation from the (second-best) welfare optimal solution as these services are not charged a mark-up based on (empirically) estimated price elasticities. Instead, the level of mark-ups is defined to guarantee that track access charges in regional rail passenger services increase with the same rate as regionalisation funds. Whether this procedure leads to a higher or lower contribution of regional rail passenger services to the total costs of providing track access remains open in absence of detailed studies.

The track access charging 2018 comes closer to an efficient pricing approach than its predecessor schemes. Nevertheless, there remain points for discussion which would need to be addressed to improve the scheme.

To these belongs the fact that the direct costs lack a sufficient differentiation by market segments to reflect cost causation. This refers in particular to differentiation by train weight (where only two different charge levels are introduced) and speed (where apparently no reflection in marginal cost prices is introduced). Overall, wear and tear seems to have less reflection than in previous schemes. Given that track users have an interest in not too complex charges, a feasible compromise is needed between the desirable level of differentiation to reflect cost causation and a sufficient degree of simplicity and transparency of the charging scheme. A related issue is the derivation of renewal costs as part of direct costs. Book depreciation might serve as a proxy in absence of sufficiently long-term observations of renewal expenditure. For future improvements of cost calculations, however, usage-dependent wear and tear should be modelled by using renewal expenditures and suitable indicators to reflect train weight, subject to data availability (see section 3.3). When comparing the current estimates with those from other countries, it should be borne in mind that due to the coverage of total investments in depreciation the estimate refers rather to long-run marginal costs. Furthermore, the inclusion of state subsidies in book depreciation implies that direct costs seem to include state subsidies of an unknown amount.[9] A feasible argument for this is that marginal costs should reflect the costs occurred independently of who pays for them. In addition, this procedure is comparable with estimates derived from engineering approaches which also derive the cost occurred independently of the source of financing.

The Ramsey-based mark-ups in freight were subject of disputes with the regulator which led to requested revisions. An ongoing study commissioned by the regulator will provide new elasticity

[9] The regulator has knowledge of this amount, however, this information is not public.

estimates for both passenger and freight transport. An open question is whether the assumed equality between final price elasticity of demand for railway services and track demand is feasible. So far, there is no scientific evidence available to confirm or refuse this assumption.

As the previous schemes, the track access charging 2018 foresees a charge reduction of 20% for so-called new traffic, applicable for ordering 10 additional train paths during at least 12 months. This provides incentives to shift traffic to rail. However, the rules in the ERegG hamper the application of this incentive for RRPS since §37 ERegG couples the increase of track charges to the increase of regionalisation funds which in fact does not allow to provide a 20% discount for additional RRPS services.

Finally, the track access charging 2018 includes only few elements to consider scarcity and to set incentives for an efficient use of tracks. To these belong the charge reductions for spatial and time flexibility on freight transport. One reason for the rather few scarcity elements might be seen in the fact that according to the procedure of track charge approval by the regulator, there was no provision of evidence on scarce capacity by DB Netz. This has finally led to the requested revision of the cancellation fees.

Currently, the major instrument to incentivise an efficient provision of tracks in a good condition is the multi-annual financing contract between the federal government and DB (the so-called Leistungs- und Finanzierungsvereinbarung LuFV). This contract sets quality standards to be met within a budget constraint, and foresees penalties for non-performance. The second instrument is the penalty scheme for delays which has been under revision by DB Netz. Provided that a proper allocation of causation (TOCs versus DB Netz) is done (and possible), and provided that the penalties are suitable to set incentives for improvements, this scheme could serve as a complementary instrument to the penalties foreseen in the LuFV for non-performance. However, since the performance of LuFV is supervised by the Federal Railway Board (EBA) and the performance regime within the access charges is regulated by BNA, a potential coordination problem could occur.

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