# Annex 6.1

- Description of how the market segmentation, the costs directly attributable to train operation and the full cost mark-ups were derived

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# 1 Market segmentation

## 1.1 Principles of market segmentation

The starting point for the underlying train path charges are the market segments identified by DB Netz AG on the basis of rail transport services.

DB Netz AG assigns all traffic on its rail network as well on that of the RNI to market segments on the basis of criteria relating to geographical range, temporal and objective factors. The crucial factors for determining the market segments are differences regarding the costs for performing transport services, their market prices or requirements in terms of the quality of service, insofar as these things can be observed by DB Netz AG. The market segmentation is based on an analysis of the other side of the market ie of applicants and of the downstream end customer and intermediate customer markets.

The initial step sees the rough segmentation of the transport services. At a minimum, there is a differentiation to be made between local passenger, long-distance passenger and freight rail transport. Following this, the initial rough segmentation is refined within these individual transport services. An important step in this process is developing and setting suitable segmentation criteria within the transport services. These segmentation criteria provide a logical basis for assigning the various services. This logical basis must be clearly arranged and be able to cover all types of traffic. Applying this assignment logic then results in the market segments for each transport service. Within themselves, these market segments must be arranged homogenously, yet display a high degree of heterogeneity vis-à-vis one another.

Moreover, the object being assigned to the transport services and market segments must be defined ie it must be decided whether one and the same train path can be assigned to different transport services or different market segments on a section by section basis. One determining factor in this process is whether the competitive conditions mirrored in the segmentation criteria change materially in the course of a train path. Secondly, the resulting complexity of the payment system needs to remain manageable. Ultimately, opportunities for circumvention need to be prevented. This results in the following principle of the flexibility of transport services:

Switching between transport services on one and the same train path is not possible. When differentiating between freight services and passenger services, this is evident just from the fact that the rolling stock is only suitable for the transportation of either freight or people, thereby precluding switching from taking place on one and the same train path. Yet in light of the current statutory framework (section 36(2) ERegG), local and long-distance rail passenger services are also to be regarded as strictly separate transport services that completely determine the assignment of a train path. Firstly, this is evident from the fact that these two services are explicitly named in the legal framework as different transport services (cf. section 36(2) of the Railway Regulation Act (ERegG)). Section 2(12) of the General Railway Act (AEG) operates on the basis of a holistic view, meaning that the focus should be on the main purpose of the transport service. The separation of responsibilities between the federal government and the individual states also takes account of the material difference between local and long-distance transportation: Art. 87e (4) of the Basic Law (GG) limits the federal government's responsibility to guaranteeing long-distance rail passenger transport services. Art. 106a GG assigns tax revenue to the states solely for local public passenger transport. Section 6 RegG stipulates that the states must use this revenue especially for local rail passenger transport. Section 2 RegG defines local rail transport as the "publicly accessible carriage of persons with regularly scheduled modes of transport", "which are mainly intended to satisfy demand in urban, suburban or regional transportation." Therefore, the differentiation occurs based on the criterion of the predominant geographical supply function attributed to the mode of transport, something which is not harmed by virtue of long-distance travellers also being served on a subordinate basis. Therefore, the funding of local transportation by the responsible party will always refer to related lines and not to switching sections of one and the same train path. Accordingly, it is predetermined by law that each train path be assigned to either local or long-distance passenger rail services. Furthermore, long-distance train paths also result in different operational requirements for path construction. For instance, longer stopping times are required than for local transport. For this reason, too, no ongoing switching between transport services on one train route is possible. Nevertheless, it is conceivable that one and the same train might operate as a local rail service on one complete section of the route and mainly transport long-distance travellers on a different section. However, switching services on one and the same train path would make pricing significantly more difficult for this train path since the two transport services are priced on fundamentally different logical bases with regards their respective geographical ranges. The pricing of local passenger rail services is governed by the area in which they operate, whereas that of long-distance passenger rail services is relational. In light of the foregoing, it would appear both preferable and practical in such an instance to refer applicants to ordering different sequential train paths with different transport services rather than to enable switching between transport services on one and the same train path. Since the operational requirements in terms of path construction for local and for long-distance passenger rail services are different, such a separation of train paths is also necessary from an operational perspective. This therefore precludes switching between transport services on one and the same train path.

The flexibility of the market segments within the individual transport services is set out in the specific sections of the annex.

Furthermore, the list of possible market segments contained in Annex 7 ERegG was assessed as to whether and to what extent the listed pairs of terms exhibited observable differences on the DB Netz AG rail network regarding the costs of performing transport services, their market prices or requirements in terms of the quality of service provision and therefore market segments that can be differentiated from one another.

Of the pairs of terms specified in Annex 7 ERegG, the following pairs were not included in the segmentation:

Domestic rail transport/ cross-border rail transport: The differentiation between domestic and cross-border transport was not included because, on the German line section relevant to pricing, the two groups do not differ materially from one another with regards the costs for providing transport services, the market prices that can be obtained in the process and the requirements in terms of quality of service.

Combined transport / direct transport: The differentiation between combined transport and direct transport was not included because DB Netz AG cannot reliably observe modal changes, meaning that DB Netz AG cannot differentiate between combined and direct services. It is certainly possible to observe whether or not a train consists of containers. However, direct services may also be completed with containers, meaning that this criterion is not suitable as a basis for differentiated pricing in this respect.

Working timetable / ad-hoc transport: Ad-hoc services are primarily relevant to freight transport. The differentiation between working timetable and ad-hoc services was not included because working timetable services and ad-hoc services do not differ materially from one another with regards the costs of providing transport services, the market prices that can be obtained in the process and the requirements in terms of quality of service. In addition, differentiated pricing would either result in train paths being registered to working timetable services although it is not yet at all certain whether the services are even taking place (this would occur if ad-hoc services were more expensive than working timetable services), or would lead to services that had already been firmly planned only being registered at short notice (this would occur if ad-hoc services were cheaper than working timetable services). Both would be detrimental to the efficient utilisation of rail infrastructure capacity.

## 1.2 Segmentation criteria for long-distance passenger rail services

With long-distance passenger rail services, segmentation of the end customer market is carried out on the basis of the volume and the structure of travellers. Since DB Netz AG cannot directly determine these characteristics, segmentation criteria need to be identified to illustrate this differentiation that are both observable and verifiable for DB Netz AG. The criteria of itinery and journey time primarily illustrate differences in passenger volume, whilst the criterion of speed illustrates both volume and the composition of travellers.

The criteria relevant to segmentation can change on one and the same train path. Ordering separate train paths that are adjacent to one another, such as for day and night services, is impractical because where there is a separate path allocation on one and the same train route, it is no longer possible to ensure the operational coherence of the route. This therefore means that switching between market segments on one and the same train path is possible in long-distance passenger rail services. The exceptions to this rule are charter/nostaligic services and services in the point-to-point segment: these market segments are characterised by stable criteria along their entire route. This therefore precludes switching out of or into these market segments from another segment on one and the same train path.

### 1.2.1 Relation

When segmenting long-distance passenger rail services, a differentiation is made between routes between metropolitan stations or high-volume border points and other routes in order to illustrate passenger volume.  Metropolitan stations are considered to be those with more than 50,000 travellers a day. Routes between at least two such stations represent an attractive market due to their high passenger potential. The overall number of travellers for local and long-distance rail passenger transport is used as a basis for determining passenger volume at the relevant railway station. This criterion appears preferable to alternatives that are also conceivable in principle:

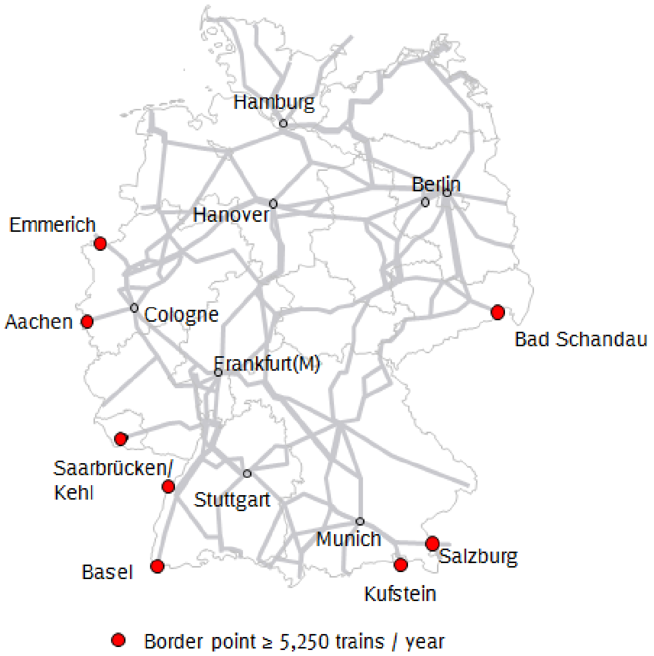
- Just including long-distance travellers would result in important stations that are currently not called at by long-distance trains (eg Berlin Friedrichstraße) being placed on the same level as small stations. This does not appear appropriate since the two groups differ considerably from one another in terms of their passenger potential.
- Including the population size of the city in which the relevant station is located does not seem appropriate because comparably small cities may also have high passenger volumes if their population has an affinity for rail travel and they have a high-volume “hinterland”. In addition, major cities generally have several stations with very different levels of passenger potential. These differences cannot be illustrated by the criterion “population size”.

A value of 50,000 travellers per day is used as the threshold for classifying a station as a metropolitan station. Since no natural value exists for this definition in the economic sense, this figure was determined on the basis of various considerations. From an empirical perspective, stations with more than 50,000 travellers per day generally have hourly connections between one another and, in addition, are served by high-capacity trains. The value of 50,000 travellers per day is already used in the DB Station & Service AG station price system as a threshold. Where the management has carried out a categorisation of stations, there is also a threshold of 50,000 travellers per day for local and long-distance rail transport used for the definition of a major station (cf. eg no. 2.1.2. Administrative provisions of the state of North Rhine-Westphalia in relation to section 13 of the Public Local Rail Passenger Transport Act (ÖPNV-G)).

The following list shows the results of an analysis of the DB Station&Service AG data for identifying metropolitan railway stations with more than 50,000 travellers per day. On the basis of the analysis, 44 stations were identified that are frequented by more than 50,000 travellers per day. This includes the following stations: Berlin Alexanderplatz, Berlin Hbf (central station), Berlin Ostbahnhof, Berlin Potsdamer Platz, Berlin Ostkreuz, Berlin Südkreuz, Berlin Zoologischer Garten, Berlin Friedrichstraße, Berlin Gesundbrunnen, Berlin Westkreuz, Bonn Hbf, Bremen Hbf , Dortmund Hbf, Duisburg Hbf, Düsseldorf Hbf, Essen Hbf, Frankfurt (Main) Flughafen, Frankfurt (Main) Hauptwache, Frankfurt (Main) Hbf, Frankfurt (Main) Konstablerwache, Freiburg (Breisgau) Hbf, Hamburg Dammtor, Hamburg Hbf, Hamburg Altona, Hamburg Harburg, Hamburg Jungfernstieg, Hannover Hbf, Karlsruhe Hbf, Cologne Hbf, Cologne Messe/Deutz, Leipzig Hbf, Mainz Hbf, Mannheim Hbf, Munich Hbf, Munich Karlsplatz, Munich Marienplatz, Munich Ost, Munich Rosenheim Platz, Munich Pasing, Münster (Westfalen) Hbf, Nuremberg Hbf, Potsdam Hbf, Stuttgart Hbf, Stuttgart Stadtmitte.*

Furthermore, intineries exist with a particularly heavy passenger volume where the start or destination station is not part of the DB Netz AG infrastructure. However, it is not possible for DB Netz to identify metropolitan areas on foreign infrastructure using an approach analagous to that used for domestic metropolitan areas. For this reason, border sites with high volume metropolitan rail services were identified on the basis of the number of trains passing across these border sites. The threshold of 5,250 trains per year is produced as follows: A 2 hour frequency with 16 trains per day is used as a basis, and this number of trains is multiplied by 365 transport days, producing a threshold value of 5,840 trains per year. To avoid hardship cases, an approx. 10% buffer for variations is applied in favour of the market, leading to a final threshold value of 5,250 trains a day [???]. For purposes of simplification, border sites which are directly geographically adjacent to one another (Basel border / Basel Muttenz; Aachen south / west border) and those with services travelling in predominantly the same direction (Saarbrücken border / Kehl border) are combined. The border sites identified in this manner are equated with domestic metropolitan railway stations in terms of the pricing logic of long-distance rail passenger transport.

**List of border points with international metropolitan rail services**




| Border points | Number of trains |
|---|---|
| Basel border/ Muttenz | 28,139 |
| Salzburg border | 14,821 |
| Saarbrücken border/ Kehl border | 8,846 |
| Emmerich border | 7,642 |
| Bad Schandau border | 6,605 |
| Aachen south/ west border | 6,571 |
| Kufstein border | 6,169 |

For assignment on the basis of the metropolitan connections, it is irrelevant whether the train stops at one or more non-metropolitan stations en route, since the main passenger volume is determined by the relationship between the two metropolitan stations. The entire itinery profits from the higher passenger volume of the metropolitan stations.

*Source: DB Station & Service AG

### 1.2.2 Service time

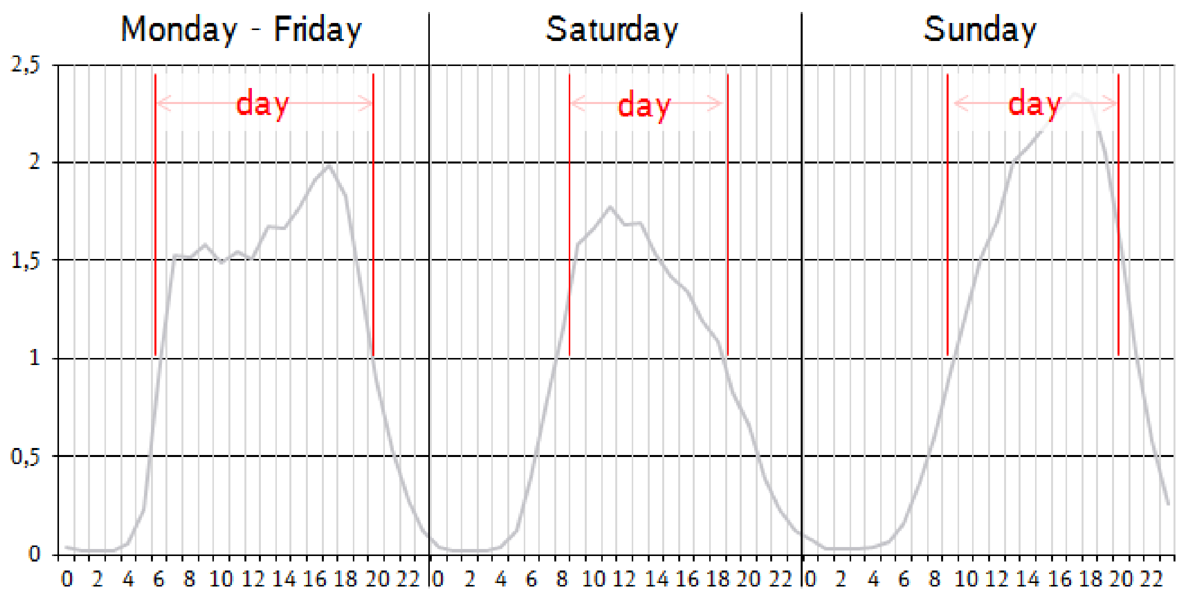
When segmenting a train route from a temporal perspective, a differentiation is made according to passenger volume, similar to that done with regards geographical segmentation. Daily and weekly load curves are the defining factor for assessing passenger volumes. The planned service time is the defining factor for assignment to a market segment according to end customer demand.

Consequently, the service time of the trains is a temporal segmentation criterion derived from the end customer requirement "departure and arrival time", since travellers' departure and arrival time is not observable and verifiable for railway infrastructure companies.

The 2008 study "Mobility in Germany" was consulted in relation to defining the terms "peak time" and "offpeak time". The data used as a basis for this study, which was carried out for what was then the BMVBS (Federal Ministry for Transport, Construction and Urban Development) was a representative survey of households on their use of modes of transportation. In the study, all routes were considered for each household and, for each route, start and finish times, the duration of the journey and the modes of transport used.

On this basis, the amount of service performed in passenger kilometres (pkm) was calculated for rail travellers. In order to derive the daily load curves from this study, journeys on rail passenger transport services were selected.

**Weekly load curve in SPFV (long-distance passenger rail services)**
relative to the weekly average (indexed as 1)




With regards the temporal segementation of the train routes for long-distance passenger rail services, a differentation is made between three characteristics: high passenger volume, low passenger volume and very low passenger volume. Passenger volume is high from 6:00 to 20:00 (Mon-Fri) and from 9:00 to 20:00 (Sat/Sun). Volume is low from 20:00 to 23:00 and from 6:00 to 9:00 (Sat/Sun). Volume is very low from 23:00 to 6:00. An additional differentiation (eg separate consideration of individual work days, separate segment for the particularly high-volume hours in the afternoon between 15:00 and 18:00) was rejected due to the associated complexity.

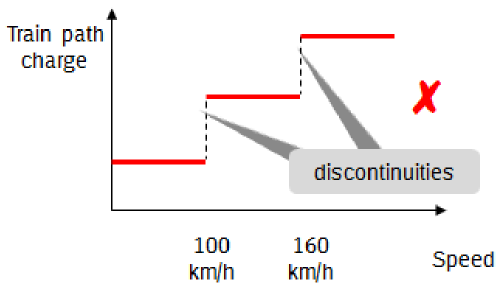
For long-distance passenger rail services, assigning train paths to the temporal market segments occurs on a minute-by-minute basis. Each individual stopping section is given separate consideration. Within the individual stopping sections, an assignment is performed on the basis of the minute-by-minute differentiation. The uniform assignment of an entire train route or stopping section according to the prevalency principle was rejected due to its objective disproportionality and the danger of opportunistic behaviour.

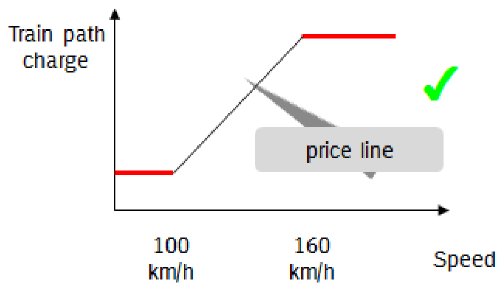
### 1.2.3 Average speed

The objective segmentation criterion of average speed is used to differentiate between trains that serve different end consumer segments. The increased willingness of end consumers to pay when journey times fall is illustrated via the criterion of average speed. The planned speed is the defining factor for assignment to a market segment according to end customer demand.

Differentiation between the services occurs in three steps. Slow, long-distance trains and high-speed trains were identified in the market segment Metro Day as being rail services with particular requirements because trains in these two speed classes satisfy largely homogenous end customer needs. Long-distance trains that travel at more than 160 km/h must satisfy particular requirements in terms of the rolling stock. The end customer segment they serve no longer changes significantly as speed continues to increase; the trains are competitive with domestic air transport. Therefore, a uniform price was created for rail services above the 160 km/h limit. Long-distance trains that travel up to and including 100 km/h also constitute a comparably homogenous market segment and, in terms of journey speed, are competing with perhaps long-distance coaches, whose speed on motorways is also restricted to 100 km/h. Therefore, a uniform price was also created for these services.

Alongside these two speed ranges, the speed profile of long-distance rail passenger transport predominantly contains services with an average speed of between 100 and 160 km/h. In this range, it can be assumed there is a gradual – rather than a threshold – change in the needs of the relevant end customers and the intermodal competitive situation. Therefore, pricing that increases linearly with speed was chosen for this market segment. Firstly, this prevents rail services becoming placed at economic risk from wage jumps at the limit values and, secondly, stops applicants from focusing timetable designs on price thresholds.




In all market segments other than Metro Day, journey speed plays a subordinate role, meaning that this was not considered for an additional differentiation of the segments.

To be assigned to the point-to-point market segment, a train may not exceed an average speed of 130 km/h between two neighbouring metropolitan areas. The restriction on maximum speed exists in order to differentiate the segment from the Metro Day segment. Typical competitive modes of transport are eg point-to-point transport via long-distance coach or by car (recommended speed 130 km/h). Since this segmentation criterion must always be considered in conjunction with the further criteria of connection, flexibility and frequency for point-to-point modes of transport, this segment also regularly handles other end consumers to services that are assigned to the Metro Day segment with the corresponding speed criteria.

### 1.2.4 Temporal flexibility

The objective segmentation criterion of temporal flexibility is used to differentiate trains in the point-to-point market segment which, in connection with the creation of the timetable, have few demands made of them in terms of their temporal operation and which are flexible in this respect. Temporal flexibility is a product of the end customer requirement for point-to-point transportation with a reduced demand for certain departure and arrival times. This manifests itself in a time window of +/- 30 minutes.

### 1.2.5 Connections

The objective criterion of connections is used to differentiate trains in the point-to-point segment that are not integrated into the network.

### 1.2.6 Frequency

The objective criterion of frequency is used to differentiate trains in the point-to-point segment for which there are a maximum of 4 journeys by the ordering RU in this transport service per transport day and direction in each stopping section ordered. The restriction on frequency occurs in order to differentiate the point-to-point segment from the Metro Day segment. Just as with temporal flexibility and the lack of network connection, pure point-to-point transport occurs at a pre-defined time without there being a linked frequency from the demand driver.

### 1.2.7 Prioritisation

The objective segmentation criterion of very high operational priority is used to illustrate very high requirements in terms of the quality of service. This includes long-distance passenger rail services which, in the event of deviations from the timetable, have particular requirements in terms of reverting to schedule. In terms of operational implementation, long-distance passenger rail service trains with very high operational priority are given preference over all other trains with the exception of urgent breakdown trains. On the demand side, this represents customer needs characterised by a particularly high demand for punctuality.

From a demand perspective, the need for operational prioritisation is stable for an entire train route. For long-distance passenger rail services, the increase punctuality requirement must apply to the entire train route, because otherwise connections and circulation plans cannot be ensured. Assignment to this market segment must therefore apply to the entire train path. Nevertheless, if the applicants formulate a need for a restriction of operational priority on parts of a train path, this need is driven not by demand but by infrastructure, such as because operational bottlenecks are limited to parts of a train route. However, this does not justify dividing this train route across different market segments.

### 1.2.8 Operating concept

The objective segmentation criterion of the operating concept is used to differentiate rail services that are provided for a mutual purpose that is the same for all participants and for which the stops are therefore only designed for either joining or leaving the train. This means the homogeneity of end customer needs is represented in a separate segment so as to differentiate it from network rail services.

### 1.2.9 Historical traction unit series and non-profit organisational purpose

The objective segmentation criterion of historical traction unit series or that of the non-profit organisational purpose is used to differentiate rail services where the main purpose is not the conveyance of end customers from one place to another, but rather to travel with a historical train. Here, too, the homogeneity of end customer needs is represented in its own segment by virtue of the significant differentiation versus other segments.

### 1.2.10 Preliminary service

The objective segmentation criterion of preliminary service differentiates between journeys that are purely preliminary services for other market segments – without passengers being conveyed – (locomotive and empty runs) and journeys where the purpose is the conveyance of passengers. Locomotive and empty runs cannot be assigned to a specific end customer-(market segment). In addition, DB Netz is unable to check such an assignment, at least not at a reasonable cost, even it is clearly possible to do so. For this reason, locomotive and empty runs form a separate segment. Because these runs cannot be assigned to a load segment, pricing is governed by the cheapest load segment within the relevant transport service.

In the course of a train path, empty/locomotive runs can regularly turn into load runs and vice versa. This does not over-complicate matters from an accounting perspective and it is not precluded by any particular operational obstacles. Therefore, changing from locomotive/empty runs to load runs can also be done on one train path.

## 1.3 Segmentation criteria for local passenger rail services

### 1.3.1 Load run

On the basis of the stipulations of section 37 ERegG, segmentation of load runs in local passenger rail services occurs exclusively according to the federal states.

### 1.3.2 Preliminary service

The objective segmentation criterion of preliminary service differentiates between journeys that are purely preliminary services for other market segments – without passengers being conveyed – (locomotive and empty runs) and journeys where the purpose is the conveyance of passengers.

In the course of a train path, empty/locomotive runs can regularly turn into load runs and vice versa. This does not over-complicate matters from an accounting perspective and it is not precluded by any particular operational obstacles. Therefore, changing from locomotive/empty runs to load runs can also be done on one train path.

## 1.4 Segmentation criteria for rail freight transport

Various end customer needs, such as those of shippers and forwarders, of the opposite market, the RUs, are translated into logistical concepts and summarised in rail freight transport. The characteristics of these different logistical concepts that are observable when ordering train paths can be used for forming market segments for rail freight transport. In some cases, these imply differences in the viability of the end customer needs served by these logical concepts. In some instances, these different logistical concepts also have an effect on the size of the direct costs of train operation. The segmentation of rail freight transport occurs on the basis of particular transport requirements resulting from the transported goods (dangerous goods) or the configuration of the train (weight, carriage length, train path length). Furthermore, market segments are formed on the basis of the flexibility of the other side of the market with regards the temporal and geographical train path.

In comparison to rail passenger transport, rail freight transport is characterised by a stable load. For this transport service, market segmentation is linked to criteria that are stable across the course of the train path. At the same time, it is entirely possible to order a separate connecting path from a different market segment where there are significant changes to the train configuration, as rail freight transport does not routinely rely on connections with other train paths or train routes.  This therefore means that switching between market segments on one and the same train path is not possible in rail freight transport.

### 1.4.1 Train weight

The objective segmentation criterion of weight is used to differentiate very heavy freight trains from other freight transport. The weight of these trains results in higher costs which are incurred as a direct result of the train operation.

The problem of being unable to verify transport weight is manageable due to very simple transport structures (only a few relationships) and the use of the registered weight by the RU.

### 1.4.2 Dangerous goods

The objective segmentation criterion of dangerous goods is used to differentiate dangerous goods block trains from other freight transport.

This criterion is characterised by the differentiation between dangerous goods transports and non-dangerous good transports. Dangerous goods transports are determined on the basis of the definition under the Dangerous Goods Regulation Road, Railway and Inland Water Way (GGVSEB, Annex 1 to section 35). Under this Regulation, a dangerous goods block train transports goods that are listed in the aforementioned source as being dangerous. Pursuant to SNB number 4.7.2, there is a strict requirement to provide a description of the goods in block trains with dangerous goods under GGVSEB (including the RID) as well as associated closed empty block trains with uncleaned tank wagons and tank containers.

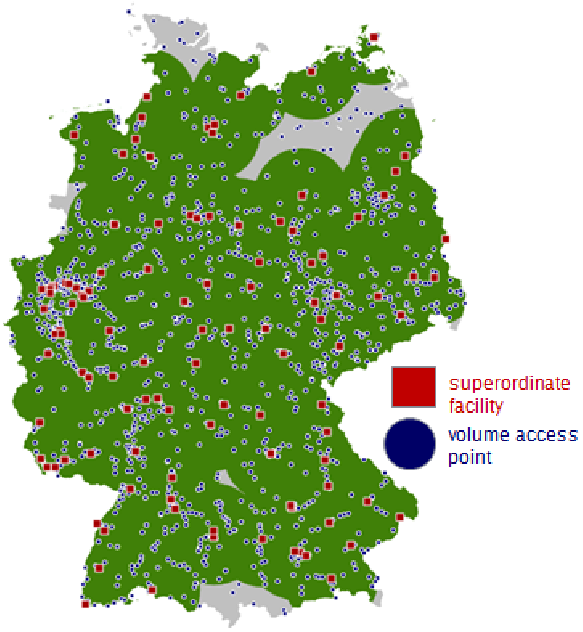
In addition, dangerous goods block trains pose particular demands on the planning and execution of the transport. Moreover, there are limited intermodal substitutions available, especially on the basis of the statutory requirements under the GGVSEB. Pursuant to DB Directive 402, RUs are obliged to provide notification of block trains with dangerous goods (under GGVSEB) when registering the train path. The aforementioned list of goods affected by GGVSEB (Annex 1 to section 35) was used for the classification process.

### 1.4.3 Train rakes and train path lengths

The freight train companies' ranges differentiate inter alia between the terms block train and single wagon transport. These two terms are used to satisfy different logistical end customer needs; in addition, they differ considerably in terms of the higher costs of assembling single wagon trains and thus the costs on the part of the RUs. During market consultation, the market expressed the wish to account for these differences by means of a separate market segment for train paths. However, the network operator is dependent upon observable approximation criteria in order to differentiate between the two market segments: whilst the handling of trains in marshalling yards that is characteristic of single wagon trains would be a specific differentiation criterion, it is not identifiable in every case for the operator of the rail network when allocating the train path. Therefore, the objective segmentation criteria of train rakes and train path lengths are used to differentiate between such trains and remaining freight services which typically cannot be produced in block trains due to small transport quantities, instead requiring system transport for the bundling of wagons. AS such, a choice was made to differentiate via train rakes and train paths.

In terms of train rakes, there is neither a natural limit, nor does a review of historical data provide a clear assignment limit for services with feeder character. As an alternative, therefore, the simplest form of system transport is assumed. This consists of splitting a block train into two halves, that is to say halving the train length. Since the maximum train length on the DB Netz infrastructure is 740 m (exception: Padbord-Maschen), the limit has been set at 370 m. This limit is also supported by the fact that a 400 m limit on train length is used in connection with the DB Netz AG facility pricing system. A train rake of 370 m essentially corresponds to a train length of 400 m.

In terms of the train path length, the limit of 75 km is the product of an analysis of the run length between volume access points (branch lines and sidings, loading and unloading areas, terminals) and superordinate facilities (≥ 130 infrastructure points, ≥ 35 % proportion of rail freight transport). The analysis shows that, with a feeder train path of up to 75 km (65 km straight line distance with an average diversion factor of 1.2), almost all volume access points can be reached from superordinate facilities. Since the reference point of the analysis is the general facility structure, this ensures non-discrimininatory differentiation.

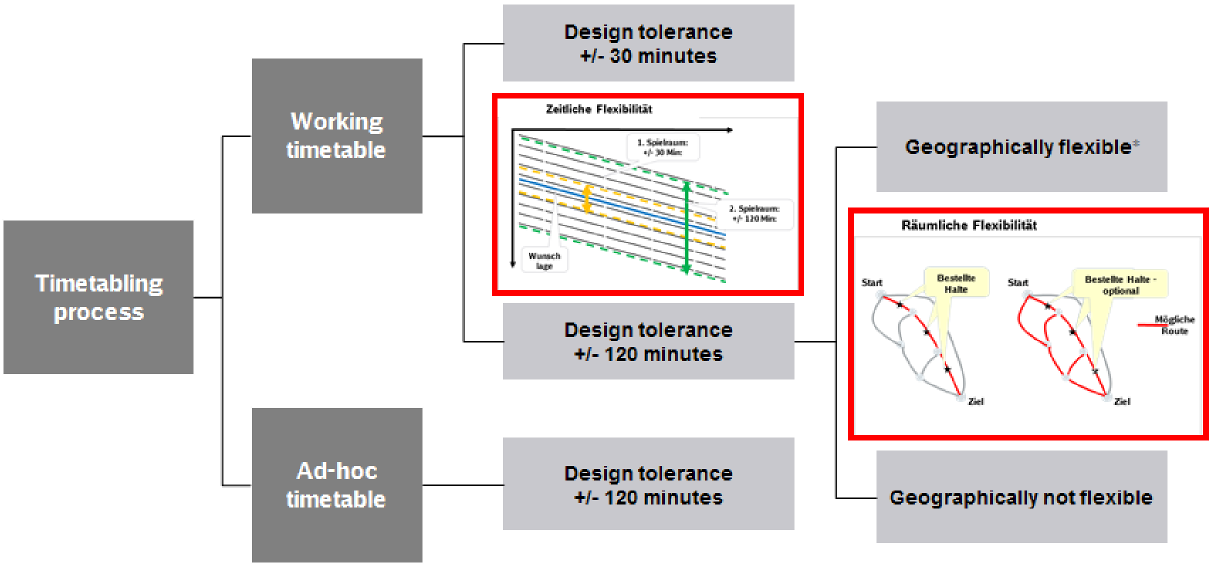



Since only the derived criteria of run length and train rake are available for differentiation purposes, there is a risk that applicants will use this to split trains that lack genuine feeder character, that is long-running, unchanged trains, into several local freight transport train paths. Due to the four hour rule, the economic incentive for this is nullified.

### 1.4.4 Flexibility

The objective segmentation criterion of flexibility (temporal and / or geographical) is used to aggregate trains which, in terms of the temporal or geographical train route, have few demands made of them in connection with the creation of the timetable, and which are flexible in this respect. As part of this, the segmentation criterion of temporal flexibility exhibits two different manifestations. These reflect the different requirements made of the accuracy of the timetable. Said accuracy is determined by the time difference between order and offer; this refers to the starting and end points and to all stops in between. The first manifestation is a time window of +/- 30 minutes to represent low temporal flexibility and secondly a time window of +/- 120 minutes as the manifestation of high temporal flexibility. The +/- 30 minute value has already been applied to the 2016 working timetable and the intention is to continue to take it into account in future. The +/- 120 minute value is being newly introduced, but has already been used in the ad hoc timetable. There is no provision for additional differentiations due to the desire to reduce complexity at the time of introduction.

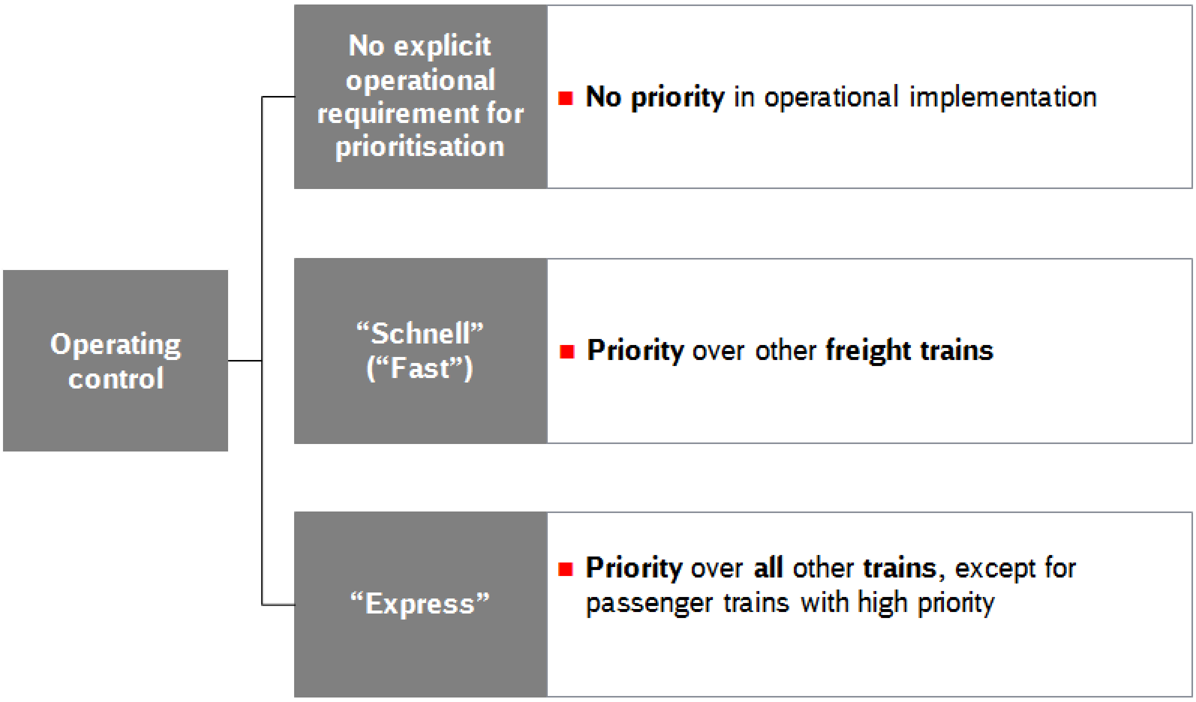
**Freight-rail timetabling process differentiation**




### 1.4.5 Prioritisation

The objective segmentation criterion of prioritisation is used to cover freight trains with high requirements in terms of the quality of service. It covers freight train paths where particular requirements are made of their operational execution regarding the reinstatement of the quality of service in the event of deviations from the timetable.

**Freight-rail operating control differentiation**




From a demand perspective, the need for operational prioritisation is stable for an entire train route. For rail freight transport, this is evident from the nature of the transported goods and / or the associated logistical requirements. Assignment to this market segment must therefore apply to the entire train path. Nevertheless, if the applicants formulate a need for a restriction of operational priority on parts of a train path, this need is driven not by demand but by infrastructure, such as because operational bottlenecks are limited to parts of a train route. However, this does not justify dividing this train route across different market segments.

### 1.4.6 Preliminary service

The objective segmentation criterion of preliminary service differentiates between journeys that are preliminary services for other market segments and journeys within the market segments. Locomotive runs are preliminary services for rail services in other market segments, the costs of which, incurred directly because of train operation, are considerably lower than journeys with carriages.

Locomotive runs in rail freight transport are regarded as a separate market, just like rail passenger transport, since in many cases locomotive runs cannot be assigned to a(n end customer) market segment. In rail freight transport, empty runs are not included in this market segment. Therefore, unlike in rail passenger transport, there is no provision for separate pricing of empty runs, something which is essentially supported by two factors: it is not possible for DB Netz AG to verify the differentiation between empty and load runs in rail freight transport. Moreover, in rail freight transport there are combinations of empty and load runs. Locomotive runs are understood to mean runs with up to three locomotives.

In the course of a train path, locomotive runs can regularly turn into load runs and vice versa. This does not over-complicate matters from an accounting perspective and it is not precluded by any particular operational obstacles. Therefore, it is also possible to change from locomotive runs to load runs on one train path.

# 2 Direct cost of train operation

## 2.1 Definition

As well as the concept of the direct costs of train operation, in political discussion and scientific literature one also finds the concepts of direct cost (in German: Einzelkosten) and marginal costs.

The following definition of the direct cost of train operation is used hereinafter when calculating them:

- Direct cost of train operation (DCTO) is the cost which is arises as an additional cost in the existing rail network by virtue of a tangible change in quantity.

A tangible change in quantity can be understood both negatively as a reduction and positively as an increase. For the sake of simplification, all additional commentary will refer solely to changes in quantity.

## 2.2 Determining the investigatory basis

The starting point for determining the direct cost of train operation is the cost of standard services (CSS). As a preliminary consideration, the CSS is adjusted for the components that have no relation to the DCTO, either because they have no relation to the DCTO in terms of content or quantity. This involves the following cost pools of the CSS:

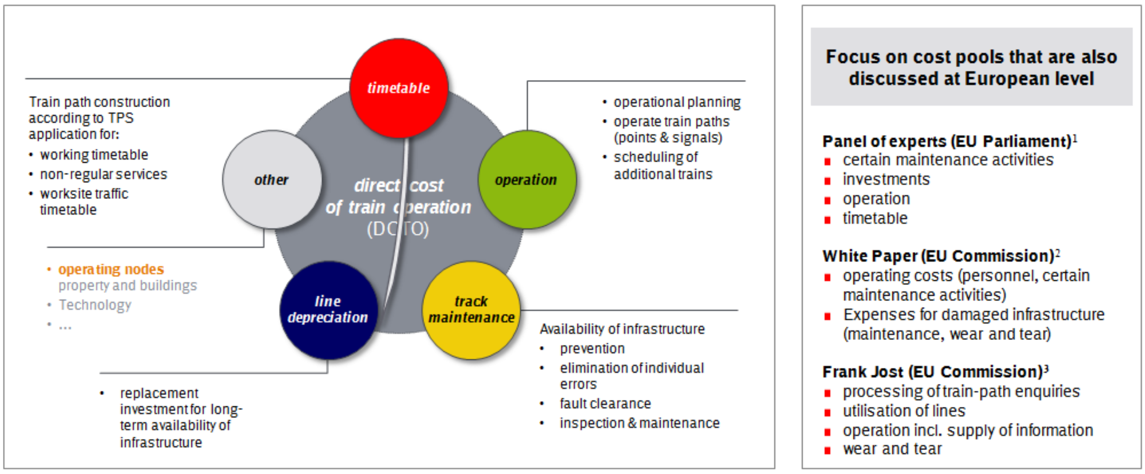
- imputed interest,
- imputed Group charges,
- other operating income (OOI),
- the non-operating income factored in (NOI),
- administrative and distribution costs (ADC) and
- costs not directly booked to the RKOST lines.

Pursuant to Commission Implementing Regulation (EU) 2015/909, group charges and administrative and distribution costs cannot be included when calculating the DCTO. Other operating income and non-operating income reduce costs when calculating the CSS and, therefore, must be included when determining the starting point for the direct cost of train operation. For costs not directly booked to the train path RKOST lines, a general assumption can be made that there is no direct exchange of services between the related RKOST and the RKOST lines. Accordingly, no relation is to be expected in terms of quantity.

This separation of the CSS produces the costs booked directly within the field of activity of the train line, which form the main starting point for all further investigations.

## 2.3 Models for determining the DCTO

Differentiating between the cost pools to be investigated follows from the discussion taking place on the European level on the content of the DCTO.




1: Link et al. (1999): Calculating Transport Infrastructure Costs: Final Report of the Expert Advisors to the High Level Group on Infrastructure Charging
2: EU-Kommision (1998): Faire Preise für die Infrastrukturbenutzung: Ein abgestuftes Konzept für einen Gemeinschaftsrahmen für Verkehrs-Infrastrukturgebühren in der EU (Weißbuch)
3: Jost (2013): Direct costs for user charges & recast under 2012/34/EU. TAC, Frankfurt

According to this, the timetable, operations, line maintenance and line DfD cost pools can be determined as DCTO relevant. Commission Implementing Regulation (EU) 2015/909 provides the first legal provision specifying the calculation and the content of the DCTO. The procedure explained is based on this legal provision. Of the aforementioned cost pools, the costs of the timetable are explicitly mentioned in Art. 3 (4) d) as a component of DCTO. It is possible to deduce that the maintenance and line DfD cost pools approach conforms with the Regulation. For one thing, the two cost pools are not explicitly contained in the list of the costs in Art. 4 which may not be included. Second, Art. 3 (4) d) permits the estimation of costs that result from the wear and tear of plaforms and points in the point infrastructure (operating nodes) caused by train operation as a possible component of the DCTO. The result of this is that running costs for the track network which reappear in the maintenance and line DfD cost pools are a component of the DCTO. The estimation of the operations cost pool is not explicitly dealt with in the legal act. DB Netz AG assumes that increasing train path kilometers will lead to increased levels of movement inspector activity and thus, as a tendency, to increased expenses for the operation of the infrastructure. Thus, the approach of analysing the ‘operation’ cost pool with regard to parts relevant to the direct cost of train operation is justified.

This must be detailed further in order to identify these cost pools within the starting point that has been identified. This happens based on the cost allocation sheet (CAS), which is used to subdivide the starting point into detailed subheadings of primary and secondary cost types. Moreover, the item “Total charge from cost centres of separate BUKR” can be evaluated with the help of cost-centre accounting according to the RKOST rendering payment.

## 2.4 Assignment of the DCTO to the market segments

The actual calculation of the DCTO occurs separately for every cost pool relevant to the DCTO. In principle, there are two model approaches available. Firstly, DCTO can be determined by means of an econometric model like a regression analysis. Secondly, the engineering method determines the DCTO by distributing the costs of the individual areas on the basis of engineering findings. One possible option here is to carry out expert discussions.

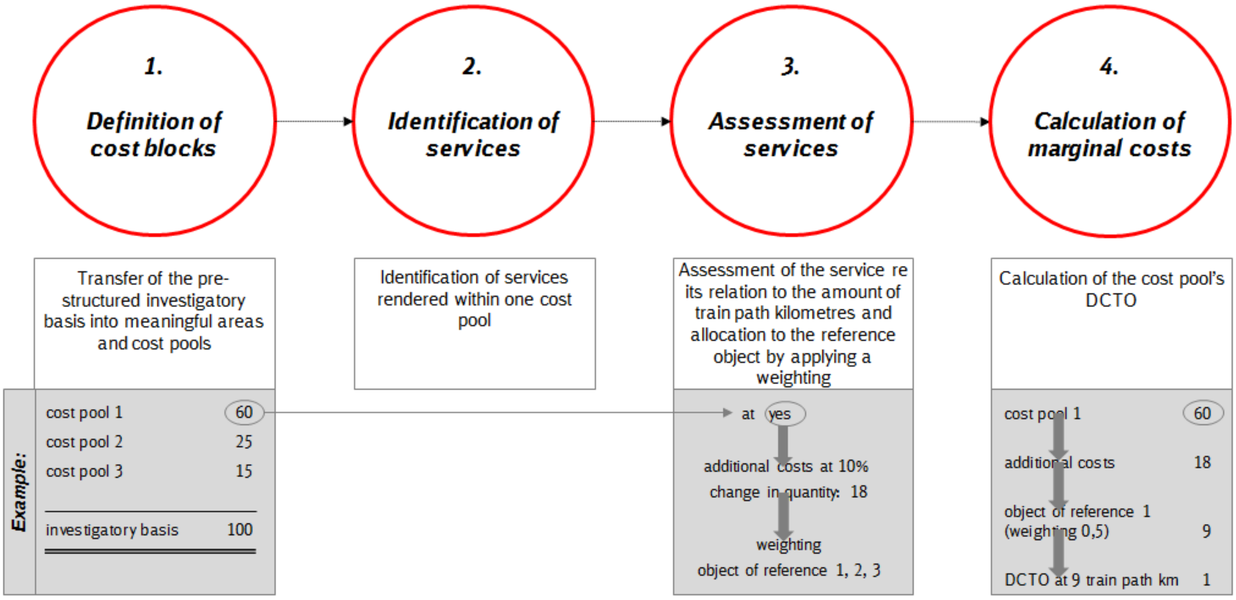
Both models have advantages and disadvantages. The econometric model provides repeatable results since it is based on provable data and predefined algorithms. The challenge is that econometric models require high-quality data in order to provide meaningful results.

Expert discussions are an appropriate and pragmatic approach to determining the DCTO. This approach identifies the driver that contributes to the occurrence of DCTO. The influence of these on the DCTO is analysed in the expert model and made transparent. Using this illustration means the expert model is easier to understand than a cost function calculated on a purely mathematical basis.

In connection with the conception of the DCTO approach, DB Netz AG has also dealt intensively with the methods of other European railway undertakings. In particular, the approaches taken by the RFF and the SBB were considered. The RFF takes a complex econometric approach. By contrast, the SBB determines the DCTO using of engineering-based modelling.

The result is that DB Netz AG considers a combined approach consisting of expert discussions and an econometric model to be the best approach for determining the DCTO for its own track network.

There are no appropriate costs related to line sections for the timetable, operations and line cost pools in the operating nodes. For these cost pools, therefore, the expert discussion is used, as it delivers the highest quality results. The expert discussion should also be used for the line maintenance cost pool, because it represents the more objectively sound approach due to the expert knowledge available.



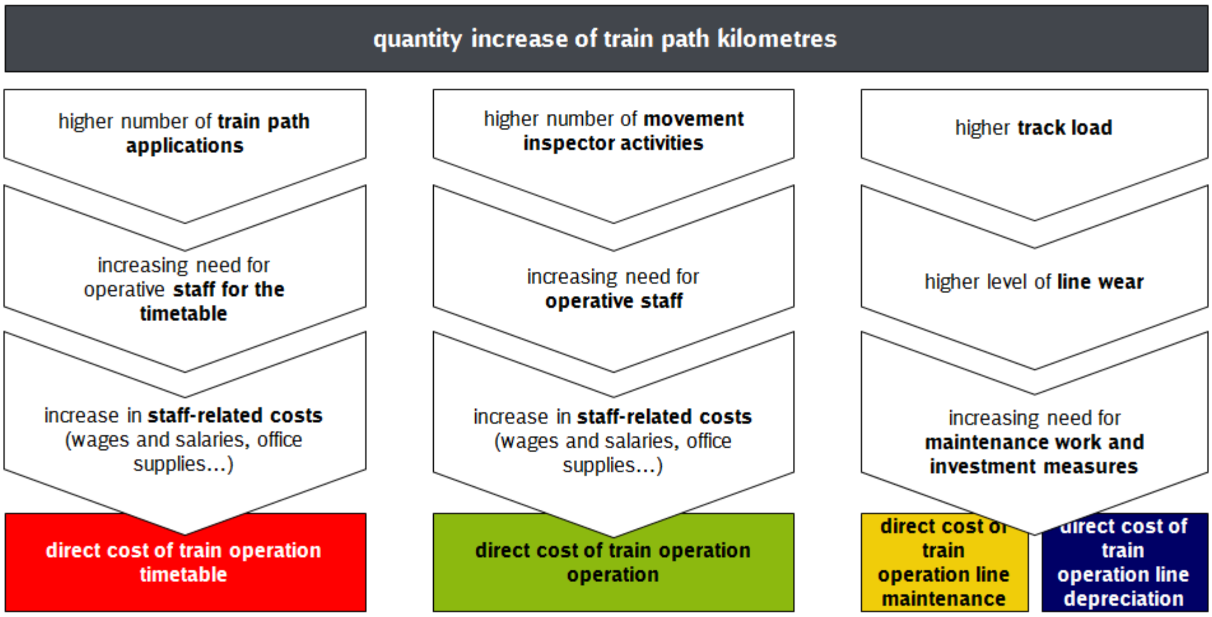

For the line DfD cost pool, an econometric model should be applied with the regression analysis. Due to the complexity and because there is sufficient appropriate data available in this cost pool, an econometric model is assessed as being more meaningful than the expert model.

Additionally, Art. 4 (1) n) of Commission Implementing Regulation (EU) 2015/909 must be considered for the DfD cost pool. This states that depreciation that is not determined on the basis of wear and tear due to train service operation may not form part of the DCTO. Therefore, purely time-dependent DfD values which are thus a product of balance sheet operating lives cannot generally be entirely recognised as DCTO. It is true that DfD values from the DB Netz AG P&L initially only represent time-dependent values, too. However, by using a regression analysis, which determines a statistical relationship between track network usage and the size of depreciations, it is possible to identify the proportion of the time-dependent values that is usage-dependent. Therefore, the regression analysis methodology satisfies the normative requirements of the Implementing Regulation.

The results of the expert discussions and the regression analysis should be reviewed on a regular basis and updated where necessary.

## 2.5 Differentiation of the DCTO according to transport services or market segments

This section explains which cost drivers lead to the occurence of DCTO. Building on this, weighting parameters will be introduced which enable the DCTO to be assigned to individual market segments. The fundamental correlation between an increase in the quantity of train path kilometers and the occurrence of DCTO can be taken from the following illustration.




In this way, an increase in the quantity of train path kilometres generally leads to increased costs in the timetable cost pool, since more train paths have to be constructed and thus more services rendered. Therefore, those train path applications that exist separately on the Train Path Portal Network (TPU) under working timetable and ad-hoc timetable can be identified as drivers.

In the operations cost pool, additional traffic results in increased operational expenditure (more service) since, for example, more points and signals must be switched. The level of activity by movement inspectors, for instance, goes up when the train path kilometres increases. Since the level of movement inspection activity is not recorded, a substitute value must be used that relates to the level of movement inspection activity. The train path kilometres are suited to this, since they are related to the number of routes laid.

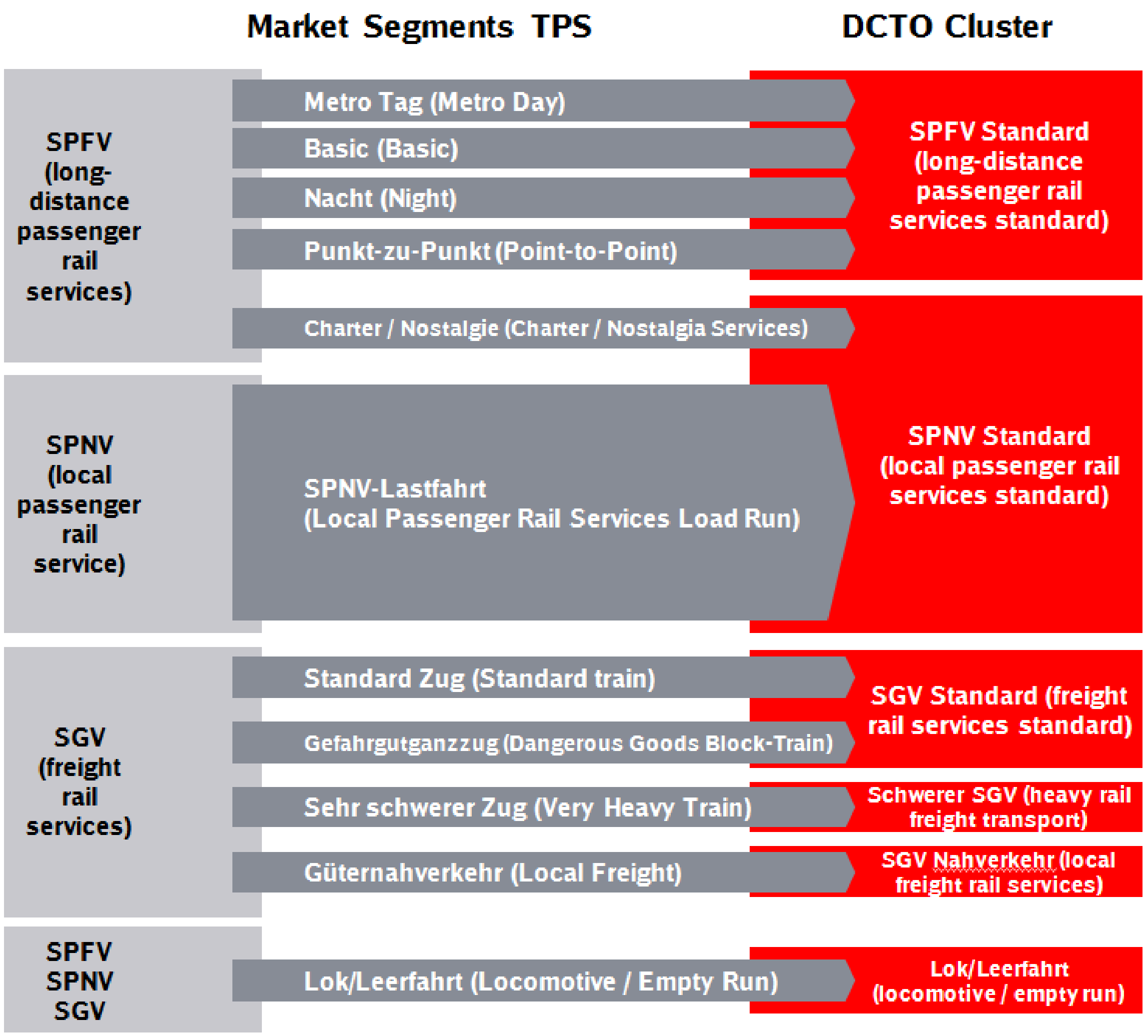
Furthermore, the increased quantity results in line facilities experiencing higher levels of wear. Therefore, there are increases expenses for the maintenance of the facilities (line maintenance cost pool). The speed and the weight of the trains are internationally recognised cost drivers that result in wear to the railway infrastructure.  In isolated cases, the number of trains can also be regarded as a driver of maintenance costs.  Here, too, train path kilometres should be used as a substitute value.

Depending on the cost pool, the assignment of the calculated DCTO occurs on the basis of one or more weighting parameters that should be regarded as cost drivers. Beyond this, DB Netz AG uses additional drivers that will be presented individually in the following sections.

## 2.6 Range of weighting parameters

The ERegG requires that remuneration is to at least be differentiated according to the three transport services of rail freight transport, publicly ordered rail passenger transport and other rail passenger transport. The future train path price system of DB Netz AG provides for a finer differentiation of remuneration whereby transport services are further subdivided into market segments determined on the market side. This means in principle that the DCTO must be calculated per market segment.

Since certain market segments can barely be differentiated from one another with regards cost drivers, several segments are aggregated into clusters for the calculation of the DCTO. The following graphic shows this transition of the market segments into the clusters according to the train path price system. The intention with this process is to aggregate market and cost views.




For locomotive and empty runs, a joint DCTO calculation is carried out for the transport services. For these runs, the weighting parameters of train weight and speed are similar for all three transport services. At the same time, the weighting parameter of train weight differs from the remaining market segments since these generally constitute full-length trains, that is to say runs under load.

With long-distance passenger rail services and local passenger rail services, there are also no material differences regarding the weighting parameters speed and train weight. Therefore, there is no further differentiation of the DCTO. Accordingly, DCTO were calculated for the Local Passenger Rail Services Standard and Long-Distance Passenger Rail Services Standard clusters.

Moreover, for long-distance passenger rail services, a separate assessment was carried out as to whether a further differentiation could be made for DCTO for conventional and high-speed long-distance passenger rail services. The analysis revealed no significant difference. Therefore, no additional differentiation was made for DCTO for long-distance passenger rail services.

For the Charter / Nostalgia market segment, the DCTO for the Local Passenger Rail Services cluster are used. The reason for this is that charter services have similar weight and speed characteristics to that of local passenger rail services.

For rail freight transport, separate consideration is made of the very heavy trains, since high train weight has a significant influence on track wear. At the same time, local freight transport is also considered separately since lower train weight causes lower track wear.

There is no need to consider the Dangerous Goods Block Train market segment separately for the calculation of the DCTO. DB Netz AG considers that the conveyed goods being characterised as dangerous has no measurable influence on the DCTO. Therefore, the DCTO for the Rail Freight Transport cluster are used for the Dangerous Goods Block Train market segment.

## 2.7 Cost pool analysis

Proceeding from our explanations given in the previous sections, the manifestations of the cost drivers for each DCTO cluster can be determined.

The number of trains, in terms of the transport performance in train path km, can be seen from commercial and distribution systems.

The cost driver weight is considered as the average train weight in load ton kilometers. This is to say that the average train weight is multiplied by the number of train path kilometers for each DCTO cluster. This ensures that the impact of cluster sizes is taken into sufficient account. In this context, the locomotive/empty run is assessed at the weight of a typical traction unit in the amount of 85 tons. The data of full-length trains were taken from the TPN for the clusters Local Rail Passenger Services Standard and Long-Distance Rail Passenger Services Standard. In rail freight transport, 3,000 tons are assumed to be the minimum weight for the Very Heavy Train segment. In short-distance freight traffic, we assume a weight of 200 tons, which comprises the weight of a traction unit (85 tons) and several cars (115 tons). The weight of the Rail Freight Transport Standard cluster can be determined by means of an analysis of LeiDis-NK. For the Rail Freight Transport Standard cluster, this value needs to be adjusted by the share of Short-Distance Freight Traffic and Heavy Rail Freight Transport.

For the driver speed, approximate reference is made to the average maximum speed that RUs indicate in their train path applications. In analogy to the driver weight, this value again is multiplied by train path km, so that the market segment sizes are appropriately taken account of in the attribution. The TPN analysis of the clusters Local Rail Passenger Services Standard and Long-Distance Rail Passenger Services Standard is based on the types of full-length trains. In rail freight transport, principally data from LeiDis-NK of DB Schenker Rail's primary trains are used. The speed of Very Heavy Rail Freight Transport is ascertained on the basis of the data for all trains weighing more than 3,000 tons. A value of 85 km/h is assumed for short-distance rail freight transport. For the Rail Freight Transport Standard cluster, the weight of all primary trains from LeiDis-NK is mathematically adjusted by the share of Short-Distance Freight Traffic and Heavy Rail Freight Transport. For the segment of locomotive/empty runs, the maximum speeds of typical electric locomotives, which reach a maximum speed of 160 or 140 km/h, is taken as a basis. With a markdown, an average maximum speed of 120 km/h is assumed for this segment.

The number of train path applications that were identified as drivers in the Timetable cost pool can be ascertained from the TPN. DB Netz AG assumes that the other driver factors, such as weight or speed, have no noticeable impact on the amount of DCTO in the cost pool Timetable. Hence, a differentiation is made only in terms of transport services with regard to the train path applications. When determining the DCTO of the DfD line cost pool by means of regression analysis, the DCTO needs not be attributed to the DCTO clusters by way of weighting parameters, as the independent variables of train path km are already shown separately for each transport service. However, additional parameters can be applied in regression analysis besides train path km that may have an impact on the cost amount.

## 2.8 Analysis of cost pools

In the following sections, the approach for the analysis of the cost pools is presented.

### 2.8.1 Cost pool Timetable

The RKOST attributed to the cost pool Timetable in a first step is described as to its functions and drivers and, in a second step, analysed with regard to whether such functions contain quantity-dependent costs.

The following functions in the central and the regional timetables were classified in the experts' discussions as quantity-induced and, therefore, relevant to the DCTO.

**Central timetable:**

- Framework agreements
- Time interval planning
- Coordination working timetable
- Coordination ad-hoc services
- Internal timetable documents
- Coordination "Operating and Engineering"

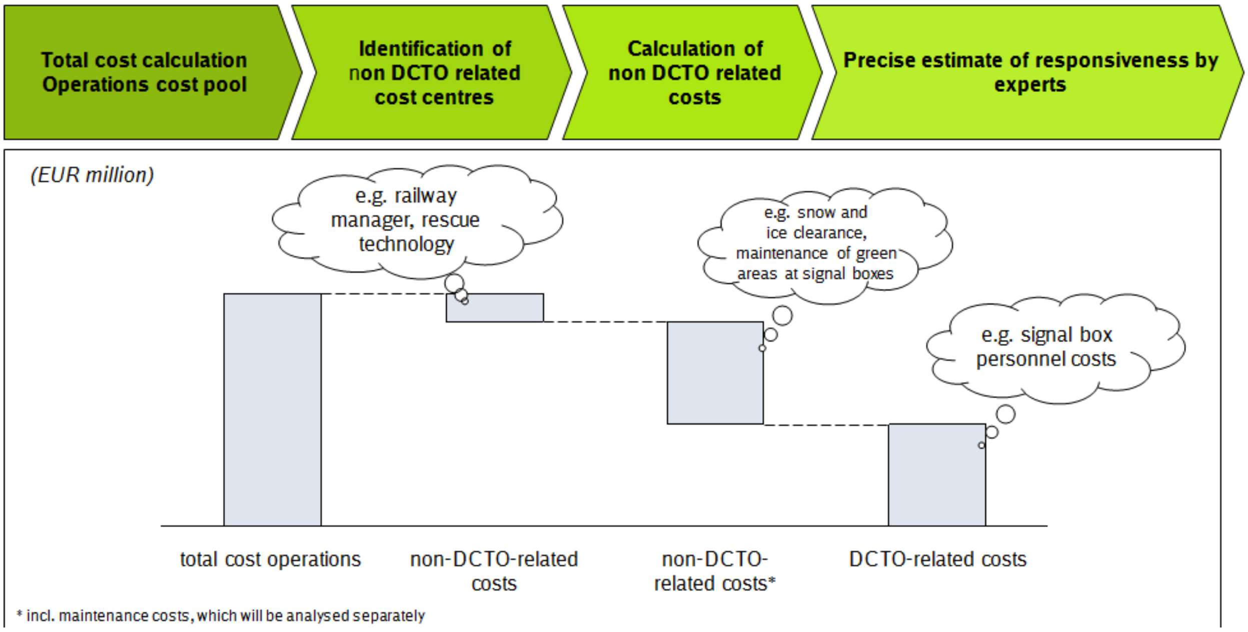
**Regional timetable:**

- Devising the working timetable
- Devising framework agreements
- Devising ad-hoc services
- Internal timetable documents
- Coordination worksite traffic timetable
- Devising the worksite traffic timetable

The costs are determined by the driver train path applications in all partial functions that are relevant to the DCTO. An additional amount of train path applications leads to an increase of working time for devising train paths. This increases staff, and staff-related, costs. All accounts of the RKOST – Timetable are analysed in expert discussions as to their (predominant) relevance to the DCTO. All those items are deemed predominantly relevant to the DCTO that respond to a change in quantity (here: of train path applications). This is true for staff costs and costs incurred for the creation of jobs. A cost responsiveness of 100% in each case is assumed with regard to the functions depending on quantity. This is to say that an assumed quantity change of 10% results in a change in costs of 10%. The costs per partial function induced by the quantity change follow herefrom. In order to determine the DCTO of the timetable for each transport service, reference was made to each transport service's share of train path applications in the total of train path applications. Train path applications broken down to market segments are not available. In this context, a differentiation was made between train path applications in the ad-hoc timetable and those in the working timetable, as demand intensity varies among the transport services.

### 2.8.2 Cost pool Operation

The RKOST attributed to the Operation division in a first step are described as to their functions and drivers and, in a second step, analysed with regard to whether such functions contain quantity-dependent costs.




In expert discussions, it was found that the functions relevant to the DCTO are to be identified in the regional areas. The corresponding areas on which a change in quantity has a direct impact are:

- Operating control of signal boxes
- Operating control of level crossing safety
- Operation management of control centres

The operative staff, such as movements inspectors and crossing-keepers, are attributed to these RKOST. The fact that these RKOST are relevant to the DCTO becomes clear from the load profiles of individual signal boxes of DB Netz AG. It is made clear here that signal boxes are staffed in dependence upon the number of train movements. Thus, the approach of analysing the cost pool Operation with regard to parts relevant to the DCTO is justified on the merits. The major driver for the costs of all relevant cost centres are trains and shunting movements, which are measurable on the basis of the indicator "train path kilometers". The more train path kilometers a train runs, the more points and signals are to be set, i.e. the more activities of movement inspectors are required. All RKOST are analysed in expert discussions as to their relevance to the DCTO. All those items are deemed predominantly relevant to the DCTO that respond to a change in quantity (here: of train path kilometers). This is true for staff costs and costs incurred for the creation of jobs. The share of the staff costs that is taken into account in the determination of the DCTO is ascertained as follows: First, the share of operative full-time employees (e.g. movements inspectors) must be determined, as these, in contrast to the administrative/dispositive full-time employees (such as executive functions), are regarded as quantity-responsive. According to Implementation Regulation 2015/909 of the European Commission, fixed costs for the provision of a line section must not be claimed as DCTO. Accordingly, minimum staffing of the signal boxes to be staffed with operative staff is regarded as not quantity-responsive. The minimum staffing is ascertained in accordance with the following formula:

$$Stw * \frac{Söz}{Waz} * (1 + Vb)$$

*Stw:* *Number of signal boxes to be staffed*
*Söz:* *average line operating hours [h/week]*
*Waz:* *weekly working time (39 h/week/full-time employee)*
*Vb:* *Need for substitutes for absences [%]*

All operative staff beyond the minimum staffing are regarded as responsive to train movements. If quantities rise in the existing network (need for more staff than the minimum staffing), the activities of movement inspectors increase, which results in an increasing need for operative staff.

As train path kilometers and the signal units required for controlling rail traffic are correlated, the costs induced by changes in quantity are distributed among the transport services on the basis of train path kilometers. The reason the values thus determined do not vary between the transport services is that the type of train (transport service) principally has no impact on the activities of movement inspectors.

### 2.8.3 Cost pool Track maintenance

The costs incurred for maintenance are recorded in the commercial systems by means of order billing and shown as a separate cost type in the master cost centres. In this process, the information about the nature and subject-matter of the maintenance measures carried out is lost. In a separate maintenance database, however, maintenance costs can be shown for each master cost centre and operating centre broken down to the order components of such maintenance.

Furthermore, maintenance expenses are incurred in the following cost pools relevant to the DCTO:

- Operations
- Line in operating nodes

Below, the general approach for the analysis of line maintenance costs within the scope of the expert model is described. The examination is based on the IDs on which bookings are made. An ID represents a given maintenance activity. In order to reduce complexity, the individual IDs are combined to clusters. The IDs combined in a cluster principally are homogeneous with regard to the damage to be repaired and the cause of such damage. In a second step, object groups form the collective designation for similar classes of assets. Out of 26 object groups on which bookings are made in the line maintenance cost pool, only four are relevant to the DCTO.

- Level-crossing systems
- Tracks
- Conductor rail systems
- Points and crossings

With regard to the other object groups, the maintenance experts do not assume any relevance to the DCTO, as a change in quantity does not result in load variation. These are primarily the object groups of signalling and telecommunications systems, which are not subject to wear and tear due to train operation.

First of all, the experts determine the cost drivers of each ID cluster. A differentiation is made here between drivers depending on train movements (number of trains, speed, and weight) and drivers that are not related to train operation (such as the age of the systems and weather conditions). The quantity dependence/relevance to the DCTO of an ID cluster can be derived from those factors. An ID cluster is deemed relevant to the DCTO whenever the experts identify an impact of at least one train movement-related driver on the generation of the damage patterns that are attributed to such ID cluster. Then, the responsiveness of costs for each cluster relevant to the DCTO is estimated. If there are drivers that are not dependent on train movements, the responsiveness of an ID cluster must principally be less than 100%. With a noticeable change in quantity (in the discussion, 10%) and the responsiveness, the costs for each ID cluster induced by quantity changes result from the direct costs of train operation. These costs result from the drivers based on train movements. The impact of other drivers – if any – was eliminated by multiplying the total costs of the ID cluster with responsiveness, so that only the responsive share of cost remains.

According to the experts' opinion, there are three drivers due to train movements for the generation of maintenance expenses relevant to the DCTO:

- Number of trains (train path km)
- Load ton kilometers (train path km * average weight)
- Speed (train path km * average maximum speed)

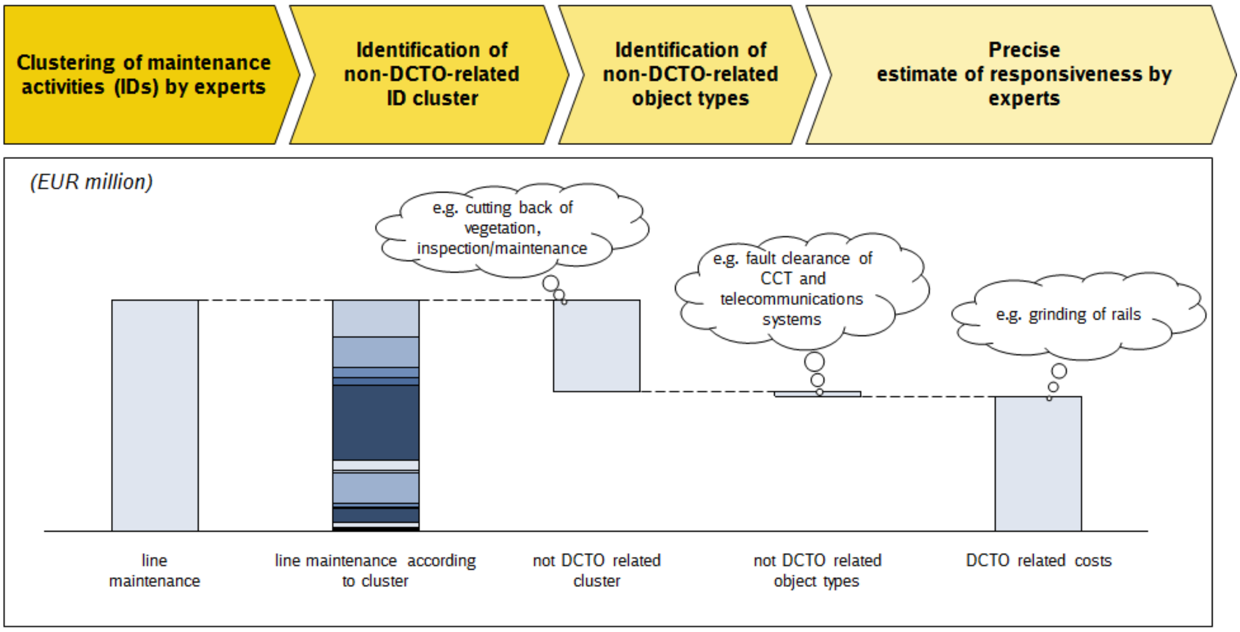
The experts determine the impact those drivers have on the generation of quantity-induced costs (0 to 100%).

The share of the DCTO for each transport service i and cluster j is determined as follows:

$$DCTO_{ij} = \frac{quantity - induced\ costs}{noticeable\ quantity\ change} * \left[x_j\% * \frac{Train\ path\ km_i}{\sum Train\ path\ km} + y_j\% * \frac{Load\ ton\ km_i}{\sum Load\ ton\ km} + z_j\% * \frac{v_i}{\sum v}\right]$$

with xj, yj and zj representing the impact of the drivers.

The following diagram provides a schematic explanation of the procedure.




In the following sections, the results of the ID clusters will be presented that the experts classified as relevant to the DCTO:

- Fault clearance;
- Other individual measures;
- Track repair;
- Sleeper repair;
- Mudregion removal;
- Point repair.

The experts' discussion revealed that the age of systems, weather conditions and the movements of trains are possible factors having an impact on the responsiveness of the fault clearance cluster. In the further course of the discussion, however, the experts came to agree that the age of the systems has only a negligible impact. The experts deem that damage exclusively due to age hardly occurs in the systems, or only at a very late point in time, which is hardly reached due to measures taken beforehand. Experience shows, however, that the impact of weather conditions can be estimated at 5% (e.g. trees lying on the tracks after windstorm). The experts accordingly estimate the cluster's responsiveness with regard to the movements of trains at 95%. Examples to be mentioned in this context include rail defects (surface and/or joining defects) and cracks. These can be caused by the strain cycles (number of trains) triggered by train movements and must be repaired at short notice, e.g. by way of machining.

A higher number of trains immediately results in a higher number of strain cycles, which cause more rail defects in tracks and points, for instance. The impact of speed is due primarily to faults in points; their frequency of occurrence depends on the speed with which they are passed. The role of load ton kilometers, in contrast, is negligible.

The costs are distributed among the market segments based on the following weighting of drivers:

- Number of trains 80%
- Weight of train 0%
- Speed 20%

The responsiveness of the cluster Other individual measures is estimated to be 80%. The non-responsive share can be explained in particular by the number of maintenance and repair intervals during which often other individual measures are carried out. The ID's of the cluster comprise various maintenance activities that are based on diverse cost drivers. For the sake of simplification, the experts thus assume a uniform distribution of the costs among the market segments of 33.3% for each of the cost drivers:

- Number of trains 33.3%
- Weight of train 33.3%
- Speed 33.3%

The experts, in a conservative approach, set the responsiveness of the cluster Rail repair at 80% with regard to the movements of trains, as it cannot be ruled out that part of the damage can be attributed also to other factors, such as weather conditions, age, quality of material.

The experts deem that the quality of rails is not influenced by the mere number of train movements as such, but in particular by the load and speed of the train movements. Hence, the experts deem the load ton kilometers and the speed, with a distribution of 50% each, to be the main drivers of costs in the cluster Rail repair.

The costs are distributed among the market segments based on the following weighting of drivers:

- Number of trains 0%

- Weight of train 50%
- Speed 50%

The responsiveness of the cluster Sleeper repair with regard to the movements of trains is set at 50%, as the experts estimate that the impact of age and that of train movements are equal. On the one hand, the dynamic load due to the movements of trains, which primarily results from the weight of the trains, is important. Here, more frequent repair, in particular of the sleeper fasteners, is imperative with a higher load. On the other hand, the age of sleepers must be taken into account, as the sleepers' material (mainly wood and concrete) with increasing age is more often subject to fatigue.

From the experts' point of view, sleeper damage is caused in particular by the load resulting from the weight of the trains. The flow of forces from the rails into the sleepers in total results in higher load on the sleepers and thus to more frequent and earlier damage in the sleepers. Accordingly, the experts deem the load ton kilometers to be the sole driver of costs in the cluster Sleeper repair.

The costs are distributed among the market segments based on the following weighting of drivers:

- Number of trains 0%
- Weight of train 100%
- Speed 0%

The experts estimated the responsiveness of the cluster Mudregion removal to be 15%. This value reflects the relatively small but existing impact of the movements of trains on the generation of mudregions.

The experts assume that the weight of a train has the biggest share in what the movement of a train contributes to the generation of mudregions due to the load or infliction of damage to the track superstructure. Also the number of trains plays an – even though less important – role in this context, as the damage of the superstructure increases with each train running. The experts do not see any impact of speed.

The costs are distributed among the market segments based on the following weighting of drivers:

- Number of trains 20%
- Weight of train 80%
- Speed 0%

In the discussion, the responsiveness of the cluster Point repair was set at 80% with regard to the movements of trains, as it cannot be ruled out that part of the damage can be attributed also to other factors, such as age and weather conditions.

The experts deem that the quality of points is not influenced by the mere number of trains running per se, but in particular by the dynamic load. The experts deem the load ton kilometers, at a rate of 80%, to be the main driver of costs in the cluster Point repair. The speed of the train movements, in contrast, is not so important and is, therefore, evaluated as 20%. This relatively low value can be explained by the fact that the points principally already are designed for the relevant speeds (construction). Hence, it is mostly the load that has an adverse impact on the components.

The costs are distributed among the market segments based on the following weighting of drivers:

- Number of trains 0%

- Weight of train 80%
- Speed 20%

### 2.8.4 Cost pool Operation maintenance

The Operation maintenance cost pool contains maintenance measures regarding facilities that are not directly attributed to the line, but to the upstream RKOST of the Operation cost pool. The determination of the DCTO for maintenance in the Operation cost pool principally follows the approach in the cost pool Line maintenance.

### 2.8.5 Cost pool Depreciation

In the DfD line cost pool, the DCTO was determined via regression analysis. It determines by way of estimation the impact of rail traffic (train path km) on the amount of depreciation of the line sections.


The rail network of DB Netz AG is divided into more than 2,300 line sections for the purpose of cost accounting. Regression is based on cross-sectional data regarding the number of trains and the amount of depreciation in each of those line sections. On the basis of these data, the cost function

*DepreciationSection = Fixed cost*Train path kmSection + DCTO*Train path kmSection*

is statistically estimated.

In this context, the train path km are used as an independent variable, while depreciation is the dependent variable. The subject-matter of the estimation are the two parameters "fixed cost" (per train path km) and "DCTO" (per train path km). The procedure and results are shown below.

First, a procedure regarding the essential aspects of regression analysis was agreed on. These are:

- Classes of assets under review

Facilities of different asset classes are to be found in the train path RKOST of DB Netz AG. For the regression analysis, however, only those classes of assets shall be considered that comply with two conditions. On the one hand, there must be a reason to assume that the relevant asset classes are principally subject to wear and tear due to the movements of trains (relevance to the DCTO). On the other hand, the technical working life must not exceed a reasonable observation period.

- Functional form of the estimated cost function

Principally, econometric modelling of costs can be made on the basis of different function types. They range from simple linear functions to non-linear functions, such as used in the Box-Cox function, for example. DB Netz AG decided to carry out regression analysis with a linear cost function, with the advantages of logical consistency (DCTO that is independent from load intensity) and simplicity and transparency.

- Normalisation and weighting

The cost function was normalised and weighted. The decisive factor for choosing the reference value “line section” was the fact that with this choice the weight of a line section in regression is proportional to the length of the line section. This seems appropriate because the result of regression thus is independent from the nature of the line section.

- Control variables

After determining the function type to be used, possible additional parameters are chosen, which besides the train path km may contribute to explain the dependent variables. Adding further parameters aims at avoiding bias.

- Development of the “best model”

Depending on whether individual additional parameters are taken into account, different regression models can be analysed. The approach of developing a “best model” first depends on the quality of the different regression models. The quality criteria primarily used are the adjusted coefficient of determination (adj. $R^2$) and, secondarily, the Akaike information criterion (AIC). On the other hand, the significance of the regression coefficient is of importance, as non-significant coefficients must be regarded as not robust. On principle, a significance level of 5% should be deemed acceptable. In order to develop a “best model”, first all of the aforementioned control variables were considered. Then, those variables were eliminated step by step that are not significant or have an adverse effect on the adj. $R^2$. Finally, a robust “best model” is realised by the stepwise elimination of non-significant additional parameters.

### 2.8.6 Cost pool Line in operating nodes

As the RKOST Line in operating nodes in terms of content does not materially differ from the RKOST Lines, the findings/results of the examination of the other cost pools in the analysis were transferred unchanged to the cost pool Lines in operating nodes.

### 2.8.7 Other

In the experts’ discussions, the RKOST attributed to the Other cost pool were not regarded as relevant to the DCTO, as it cannot be seen that a quantity change would entail a change in costs of these RKOST. Furthermore, the 11 RKOST with the highest load on tracks were once again considered separately. In that analysis, too, no dependence on quantity could be identified.

# 3 Viability

The charges system pursuant to Directive 2012/34/EU provides that the train path charge per market segment is composed of the components DCTO, the mark-up on full costs, as well as other elements. The level of charges must not, however, exclude the use of infrastructure by market segments which can pay at least the cost that is directly incurred as a result of operating the railway service, plus a rate of return that the market can bear. Pursuant to section 36 (2) ERegG, the mark-ups must be determined in such a way that the transport services freight service and passenger service cover the total cost incurred by the operator of the railway tracks. The costs are distributed by way of the relative viability of the relevant transport services and their market segments in accordance with section 36 (2) and section 37 (4) and 5) ERegG. Furthermore, the mark-ups are to be determined such that the best possible competitiveness of the segments is ensured.

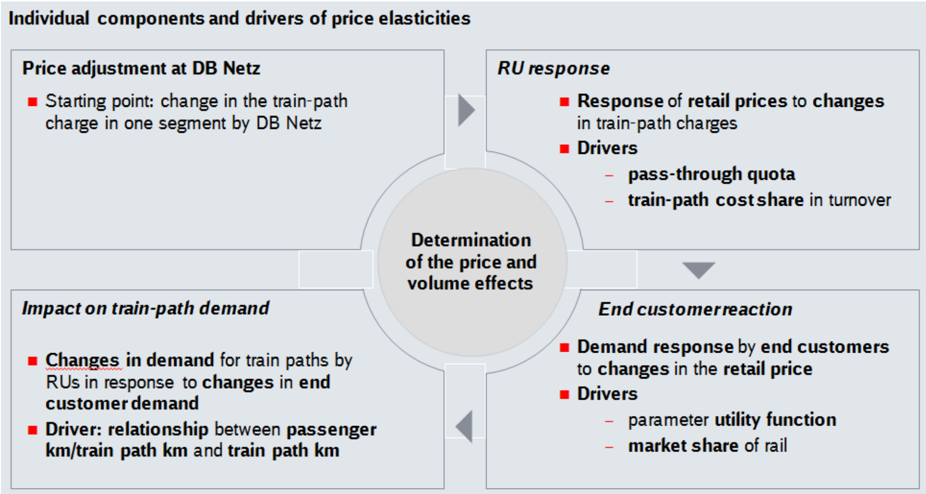
The Ramsey-Boiteux principle meets these requirements; it aims at maximising welfare in a natural monopoly on the ancillary condition that the costs of the provider (here: DB Netz AG) be covered by turnover. This optimisation problem is solved by means of the following formula:

$$\frac{p_i - DCTO_i}{p_i} = \frac{\lambda}{\varepsilon_i} \qquad (1)$$

with $\varepsilon_i$ corresponding to the price elasticity of the demand in the market segment i (in the case at hand, price elasticity of the demand for train paths). $p_i$ is equivalent to the price in the market segment i. The values of the parameter $\lambda$ can be between 0 and 1; it determines the level of charges: the higher $\lambda$, the higher the charges level. In order to be able to calculate the train path price per market segment, the DCTO and the price elasticity of train path demand must be determined for each market segment. The determination of $\lambda$ then results from the ancillary condition that the sum of the price per market segment, multiplied with the quantity per market segment, must be equivalent to the overall cost.

## 3.1 Determination of train path price elasticity in rail freight transport (SGV) and in long-distance rail passenger services (SPFV)

The determination of the price elasticity of the demand for train paths in rail freight transport and in long-distance rail passenger services is based on the following approach:




The diagram is explained below based on a fictitious example:

Let's assume DB Netz changes the train path charge in a given market segment by 10%. Assuming the share of the train path charges in the turnover of RUs in that market segment is 20%, this change of the train path price means a change of the overall cost of the RUs by 2%. The RUs will eventually shift the entirety of this cost change to their customers: in the case of a cost reduction, competition will require such shifting; in the case of a cost increase, shifting is mandatory in order to avoid durable losses. We therefore assume a shifting ratio of 100%.

Depending on how price-sensitive end customers are, they will modify their demand behaviour. At this point, we assume as an example a price elasticity of the end customers' demand of -0,5. In other words: a change of end customer prices by 2% results in a change in end customer demand by 1%. This change in quantity will be reflected identical in train path demand, assuming that the utilisation ratio of the RUs remains unaffected by the change in demand in the long term. This is to say that a change of the train path prices by 10% results in a change of train path demand by 1%.

The required elasticity of train path prices thus can be formulated as the product of end customer elasticity and the share of train path cost in the turnover. The share of the train path cost in the turnover can also be seen as the quotient of the price per train path km and turnover per train path km. This results in the following:

$$\varepsilon_i = \varepsilon_{EK} * \frac{p_i}{U}, \qquad (2)$$

with $\varepsilon_{EK}$ designating the end customers' elasticity and U the turnover per train path km.

### 3.1.1 Turnover in long-distance rail passenger services

The average turnover per train path km in long-distance rail passenger services is the product of the average occupancy per train path km and the average turnover per passenger. The annual report of DB Fernverkehr AG, which holds a market share of approx. 99% in long-distance rail passenger services and, therefore, can be regarded as representative for this transport service, shows an average occupancy of approx. 275 passengers throughout all market segments based on the quotient of traffic and operational performance. As no conclusions are available from public data regarding segment-specific occupancies and turnover per passenger km, qualified estimates were used. Such estimates are based, inter alia, on the different seat capacities due to the use of different rolling stock in the segments. As an example, the use of the ICE1 or ICE2/3 in a double-traction regime (each approx. 800 seats) primarily in higher quality segments can be mentioned as compared to loco-hauled trains with 5-7 carriages (approx. 500 to 550 seats) in the Basic segment.

The average turnover per traveller (turnover per passenger km) is determined by dividing the turnover by transport performance. This results in a value of approx. EUR 0.100/passenger km. The spreading of the turnover per passenger km for the segments was derived from real market data regarding distances, speed, and the normal price. Representative long-distance traffic relations have been examined for that purpose with regard to the dependence of the end customer prices from speed.

### 3.1.2 Turnover in rail freight transport

With regard to rail freight transport, the railway market investigation of the Federal Network Agency (BNetzA) revealed a turnover per train path km of EUR 19.90. This investigation, however, refers to 2015, while the figures given above for long-distance rail passenger services are valid for 2016. In order to make the two sources comparable, the rail freight transport turnover is dynamised by 2%. This development is roughly in line with the previous years and results in a turnover of approx. EUR 20.30/train path km. While an identical turnover per train path km can be seen in the load segments Very Heavy Train, Hazardous Materials Block Train, and Standard Train, short-distance freight traffic generates less turnover per train path km due to its properties, such as a clearly shorter length of trains. The spreading is determined by means of a qualified expert's estimate.

### 3.1.3 End customer elasticity in long-distance rail passenger services

End customer elasticity in long-distance rail passenger services was ascertained by TNS Infratest Verkehrsforschung. End customer elasticity is a function of a total of four different parameters: income, rail market share, transport costs, and the purpose of travelling.

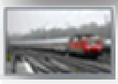
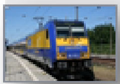
$$\varepsilon_{i,j} = \left(\beta_{i,j} + \frac{\alpha_{i,j}}{x_{i,j} + \gamma_{i,j}}\right) \cdot \left(\frac{Einkommen}{\mu(Einkommen)}\right)^{\lambda_{i,j,Einkommen}} \cdot (1-p) \cdot x_{i,j}$$

Glossar:

$\varepsilon_{i,j}$ : *Elastizität von Verkehrsmittel i bezogen auf Attribut j*
$p_i$ : *Marktanteil der ALternative*
$i$ : *Satz von verfügbaren Alternativen*
$x_{i,j}$ : *Eigenschaft j (Fahrzeit; Kosten) der Alternative i*
$(\beta, \alpha, \gamma)_{i,j}$: *Parameter zur Bewertung von* $x_{i,j}$
$\lambda_{i,j,Einkommen}$ : *Interaktion der Bewertung von Eigenschaft j mit dem Einkommen der befragten Person*

**Glossary:**
"Einkommen" income
"Elastizität von Verkehrsmittel i bezogen auf Attribut j" elasticity of mode of transport i in relation to attribute j
"Marktanteil der Alternative" market share of the alternative
"Satz von verfügbaren Alternativen" set of available alternatives
"Eigenschaft j (Fahrzeit; Kosten) der Alternative I" feature j (running time; cost) of alternative i
"Parameter zur Bewertung von x" parameters to assess x
"Interaktion der Bewertung von Eigenschaft j mit dem Einkommen der befragten Person" interaction between assessment of feature j and the income of the person interviewed

The values that the aforementioned parameters take in the individual market segments were determined on the basis of the 2008 study "Mobilität in Deutschland" (Mobility in Germany), which in each case shows average values for the long-distance traffic as a whole. The segment-specific input parameters then result from the segment criteria of travel time, relation, and travel speed. To the extent practicable, these, too, were derived from the MID data surveys. If no data surveys were available, expert estimates were used. The table below gives an overview of the turnover and elasticities in end customer demand in the long-distance rail passenger services segments:

| Market segment | | Turnover / train path km | Elasticity of end customers' demand |
|---|---|---|---|
|  | **Metro Tag Max (Metro Day Max)** | 45.08 EUR | -0.435 |
|  | **Metro Tag Min (Metro Day Min)** | 20.48 EUR | -0.528 |
|  | **Basic (Basic)** | 18.62 EUR | -0.559 |
|  | **Nacht (Night)** | 8.19 EUR | -0.609 |
|  | **Charter / Nostalgie (Charter / Nostalgia Services)** | 12.10 EUR | -0.661 |
|  | **Punkt-zu-Punkt (Point-to-Point)** | 18.62 EUR | -0.642 |

For more details on the calculation logics, reference is made to the study "Berechnung von Preiselastizitäten im Personenverkehr" (Calculation of price elasticities in passenger services) prepared by TNS Infratest Verkehrsforschung in cooperation with the ETH Zurich.

### 3.1.4 End customer elasticity in rail freight transport

With regard to rail freight transport, end customer elasticity for the segments "Standard Train" and "Very Heavy Train" was examined by Beratergruppe Verkehr und Umwelt GmbH (BVU). (The two segments differ only with regard to train weight, which is relevant for determining the DCTO. From the end customers' point of view, however, the train weight is irrelevant, so that the same end customer elasticity is applied.) The approach for determining elasticity is mostly identical with that chosen by TNS with regard to long-distance rail passenger services in order to achieve comparable results.

BVU

$$\varepsilon = \beta \times x^{\lambda} \times (1 - p)$$

**Glossar:**

$\varepsilon$ : *Elastizität*
$\beta$ : *Gewichtungsparameter*
$x$ : *Transportkosten*
$\lambda$ : *Parameter BoxCox*
$p$ : *Marktanteil der Alternative*

**Glossary:**

"Elastizität" elasticity
"Gewichtungsparameter" weighting parameters
"Transportkosten" transport costs
"Parameter BoxCox" parameter BoxCox
"Marktanteil der Alternative" market share of the alternative

In addition to the weighting parameter estimated by BVU, elasticity depends proportionally on the market share (1-p) and the transport costs x. For the transport costs amount, the median was ascertained on the basis of empirical data. The (intermodal) market share of the train was derived from the traffic interaction matrix of the 2011 reporting period forming the basis of the 2015 Federal Transport Infrastructure Plan (BVWP). The end customer elasticity thus determined amounts to -1.32.

For more details on the calculation logics, reference is made to the study "Modellgestützte Ermittlung von Preisnachfrageelastizitäten für ausgesuchte Segmente im Güterverkehr" (Model-based determination of price demand elasticities for selected segments in freight transport) prepared by BVU.

The end customer elasticities for the special segments "Short-Distance Freight Traffic" and "Hazardous Materials Block Train" were ascertained by the market research company "Produkt und Markt" in cooperation with Schlei Rabenhorst Partnerschaft on the basis of data specifically collected for this purpose. The empirical approach is mostly equivalent to that chosen by BVU and TNS infratest. When determining the results, also the segment "Standard Train" was analysed in order to ensure optimal comparability of the results; the value thus ascertained was normalised to 1. This results in elasticities of -1.056 for the segment Hazardous Materials Block Train (0.8 times the value of the "Standard" segment) and of -1.86 for the segment "Short-Distance Freight Traffic" (1.41 times the value of the "Standard" segment).

## 3.2 Determination of train path price elasticity in long-distance rail passenger services

Pursuant to section 37 (2) ERegG, the average charges for each *Land* are to be determined in such a way that they are equivalent to the average charges in the relevant *Land* in the 2016/17 working timetable period. To the extent the total amount of the regionalisation funds owed to the *Länder* has changed since 2017 up to the year when the charge actually is to be paid, the charges determined pursuant to sentence 1 shall be adapted at a uniform modification rate for all *Länder*. The elasticity of the end customers' demand is determined in such a way that the statutorily required dynamisation rate results for local rail passenger services in order to apply the principle of Ramsey-Boiteux pricing also to local rail passenger services.

## 3.3 Calculation of lambda and charges

Based on the Ramsey-Boiteux rule, which was explained at the beginning of this chapter, the price calculation formula results from applying (1) and (2).

$$p_i = DCTO_i + \frac{U_i}{\varepsilon_{EK_i}} * \lambda$$

This is to say that the price depends only on the input parameters marginal costs, turnover per train path km, and end customer elasticity. By means of $\lambda$, the price for all segments of the transport services can be finally calculated, with $\lambda$ being identical for all segments in order to comply with the condition of the Ramsey rule. The calculation of the 2019 train path charges of DB Netz AG is based on a value of $\lambda = -0.0991$.

The function of these formulas can be explained best on the basis of a simple example: Let's assume that passenger services were attributed costs in an amount of EUR 4,300 million in the distribution of costs pursuant to section 36 (2) ERegG, which now are to be distributed among the three – fictitious – market segments (a) high-speed long-distance rail passenger services, (b) conventional long-distance rail passenger services, and (c) local rail passenger services. The following parameters apply to the three mentioned market segments:

| | Quantitiy [train path km] | DCTO [EUR/train path km] | RU-turnover [EUR/train path km] | End customer elasticity |
|---|---|---|---|---|
|  HGV | 75 | 1.2 | 50 | -0.5 |
|  Konv. SPFV | 75 | 1.2 | 24 | -0.6 |
|  SPNV | 650 | 0.7 | 16 | -0.3 |

In order to ascertain the mark-ups on the DCTO for the individual segments, the parameter λ must be calibrated in such a way that the sum of train path revenue amounts precisely to 4,300. In this context, the higher the absolute value of λ is, the higher the charges level. In the example at hand, the value of λ required for a charges level of 4,300 amounts to approx. -0.08114. This results in the following charge amounts:

| | Quantitiy [train path km] | DCTO [EUR/train path km] | RU-turnover [EUR/train path km] | End customer elasticity | Mark-Up [EUR/train path km] | Charge [EUR/train path km] | Turnover operator of railway tracks [EUR] |
|---|---|---|---|---|---|---|---|
|  HGV | 75 | 1.2 | 50 | -0.5 | 8.11 | 9.31 | 699 |
|  Konv. SPFV | 75 | 1.2 | 24 | -0.6 | 3.25 | 4.45 | 333 |
|  SPNV | 650 | 0.7 | 16 | -0.3 | 4.33 | 5.03 | 3268 |

The sum of the train path charges throughout the three segments is equal to the costs of 4,300 to be covered, due to the corresponding calibration of the parameter λ.

## 3.4 The particular cases of locomotive and empty runs

Due to a lack of a direct relation to the end customers, the charges for locomotive and empty runs in rail passenger services and of locomotive runs in rail freight transport are principally calculated on the basis of a mixed calculation of the load segments of the relevant transport service (rail passenger service or freight transport). However, in order to avoid the paradox situation of a locomotive run being more expensive than the subsequent laden journey, the charge for locomotive and empty runs is determined in such a way that it is equivalent to the charge for the cheapest laden journey in the relevant transport service (rail passenger service or freight transport). In order to avoid that locomotive runs in rail passenger services are priced differently, depending on whether it is long-distance rail passenger services or local rail passenger services, long-distance rail passenger services and local rail passenger services are considered jointly for this purpose.