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# Track Access Charges in the European Union Railroad Sector: A Consideration of Company Organization and Institutional Quality

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# Track Access Charges in the European Union Railroad Sector: A Consideration of Company Organization and Institutional Quality

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**Abstract:**
Track access charges are the main driver of infrastructure costs for rail operators in the rail transport sector, accounting for up to 88 percent of costs. This paper analyzes track access charges of 28 EU countries with the respective trajectories of the company forms employing panel regressions to unbalanced panel data for the period 2011 to 2019. As a result, a fundamental correlation between company forms and track access charges could be determined. Starting from a vertically integrated company, massive cost advantages could be identified for unbundled and partially privatized company forms by avoiding efficiency-impeding behavior. The results shed light on the European railroad packages and their national implementation.

**JEL-Codes:** L11, L14, L42, L51, L52

**Keywords:** Track Access Charges, Railroad Sector, Institutional Quality, Transportation, Industrial Policy

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# 1 Introduction & Motivation

The rail sector is to form the backbone of the climate-neutral transport transition in the European Union (European Union 2021). The EU's goal is to create a single European market for rail transport services through bundles of measures (rail packages) (EU-Commission 2012, p. 1). The national implementation of these laws has so far taken place with a time lag and delay in terms of content.

As a result, the respective situation within the individual EU countries is very heterogeneous. The entire spectrum is represented, from vertically integrated companies to partially privatized companies to full privatization (United Nations 2017, p. 31). The different dividing lines between the essential components of the rail transport system (rail infrastructure, rail operations, rail transport services) vary widely (Janicki 2016, p. 24 ff.). For the customers of the rail infrastructure companies, the rail transport companies, infrastructure costs play a role, among other things. These consist of charges for the track, stations, and other service facilities. The track charge, which is paid to the respective rail infrastructure manager for the use of the rail infrastructure, can account for a share of up to 88 percent in rail passenger transport prices (Janicki 2016, p. 193; BNetzA 2019, p. 79). The study presented here analyzes the presumed relationship between company forms, track access charges and the development of the institutional framework by the EU. It is assumed that, starting from the historically developed vertically integrated company form, other company forms offer lower track access charges. In this study, two questions are to be answered.

(i.) Is there a relationship between types of companies and track access charges?

(ii.) Is there a relationship between track access charges and the development of the ownership structure?

# 2 Theory

Oliver Hart's (1986; 1990) assumptions and theories will play a fundamental role in our study. Hart examined various sectors of public services which have increasingly become the focus of privatization measures in recent years. Hart fundamentally builds on the findings of Coase and Williamson, but chooses a completely different perspective. While Coase and Williamson base their decisions on the level of transaction costs, Hart sees the distribution of rights of disposal

between the contracting parties as an essential regulatory instrument between the variables of cost savings or quality optimization.

## 2.1 Transaction costs according to Coase

Originally conceived by Coase (Coase 1937), transaction cost theory is considered the cornerstone of New Institutional Economics (NEE). Coase started from an amazingly simple question: Why do firms exist if the decentralized coordination of individual plans through markets is more advantageous?

First, Coase notes that the functioning of a market, i.e., resource management, obviously entails costs. By the entrepreneur these market costs are reduced, however, since the entrepreneur can trade production factors at a more favorable price than the valid market transaction costs. Coase recognized that enterprises exist only because transaction costs exist. The entrepreneur is thus a living "coordinator." (Coase 1937, p. 392). Therefore an organization (an enterprise) is regarded also as pure contract network that by the entrepreneur as a coordinator, a more efficient resource allocation can ensure (O. Hart 1989, p. 1763 - p. 1765; Jensen and Meckling 1976, p. 314). Consequently, Coase identifies that a firm has a "naturally" bounded optimal firm size. If the coordination costs within a firm are equal to the coordination costs incurred for market-side provision, or costs of organization by another firm, a firm has reached optimal firm size (Coase 1937, p. 394 - p. 395).

## 2.2 Transaction costs according to Williamson

Williamson further developed Coase's approach in 1967 (Williamson 1985). Williamson examines, which control and domination forms under consideration of the product specificity and transaction frequency is most efficient (O. Hart 1989, p. 1762). Williamson accepts market inefficiencies with the advancement of the transaction cost theory and stresses the advantage of possible savings of transaction costs. It assumes thereby fundamentally that transaction costs result from the limited rationality of the acting participants in connection with the specificity of the investments, Opportunismus as well as the complex surrounding field, in which they exist (Williamson 1985, p. 6).

There are two basic behavioral assumptions associated with these contracts and the contracting parties. (i.) It is assumed that the contracts entered into are incomplete, due to limited rationality of the contracting parties and simply for cost reasons (O. Hart andMoore 1985, p. 39;

Williamson 1988, p. 67 - p. 68). This means that while it is assumed in principle that each person tries to act rationally, only a limited amount of information can be absorbed. Also, a person tends to make mistakes and exhibits limited knowledge. All these factors favor inefficiency. Thus, not all possibilities or events can be considered in a contract, consequently, incomplete contracts must be assumed (O. Hart 2017, p. 1732 - p. 1735). When scenarios or actions that are not contractually secured occur, the need for renegotiation arises. Also, it simply does not make economic sense to try to cover all conceivable contingencies through contractual clauses. (ii.) As a result of incomplete contracts, the second behavioral assumption, opportunism, arises. Here, it is assumed that all contracting parties try to gain their own advantage from an incomplete contractual relationship. Opportunism can occur in many forms. For example, in addition to malice, the withholding of information or broken promises and forgeries are also mentioned. This behavior can be corrected, for example, through active competition. In that case a change of the transaction partner would represent a possibility of resolving the situation (Williamson 1988, p. 67 - p. 68; 2000, p. 601, p. 605).

### 2.3 Company integration according to Hart

Hart builds his research fundamentally on the research of Coase (Coase 1937) and Williamson (Williamson 1971; 1985). While Coase examines the question of in-house and outsourced production on the basis of contract costs, Williamson develops an efficient control and monitoring system assuming incomplete contracts. Hart further states that the previous approaches of Coase and Williamson are based on the level of transaction costs, which is dealt with differently by both authors, but which does not allow any statement about the benefits of integration within the company (Grossman and Hart 1986, p. 692 - p. 693). Hart compares thus no non-integrated result with a result which would come off by a complete contract, but the contractual distribution of remainder rights and with it the distribution of the power of disposal (Grossman and Hart 1986, p. 716).

Hart divides contractual rights into specific rights and residual rights. If a contracting party wishes to acquire specific rights from another contracting party, it must fix them in the contract. However, if this is not economically feasible for reasons of specificity or quantity, it is more profitable for the contracting party to acquire all rights. This does not apply to the specific rights that have already been contractually fixed. However, if these are also acquired, Hart speaks of ownership. However, a complete withdrawal of the remaining "residual control rights" leads to incentive distortions in the management of the acquired company, thus the question of an

efficient distribution of the residual control rights arises (Grossman and Hart 1986, p. 692, p. 716). This has implications for investment retention, quality, and ultimately the efficiency of the firm. Hart argues that along with greater control rights, the contracting party also has greater power of disposition, and therefore earns increased returns and exhibits more pronounced investment behavior (Grossman and Hart 1986, p. 716 - p. 717; Hart 2012, p. 70 - p. 71). Thus, the optimal ownership structure exists at the point where investment distortions are lowest (Grossman and Hart 1986, p. 710). This insight can be further elaborated with an example of the performance of a public service contract. Assuming incomplete contracts, there are basically three possible ways to provide services (see Figure 1). The decisive factor here is the distribution of the remaining control rights within the organization. In the case of service provision by a private company, the remaining control rights are held by a private owner. In the case of a purely public enterprise, the residual control rights are held by the state. In the last possible form, a mixed enterprise consisting of private and public ownership, the division of residual control rights determines the orientation of the enterprise (Hart, Shleifer and Vishny 1997, p. 1128 - p. 1129).

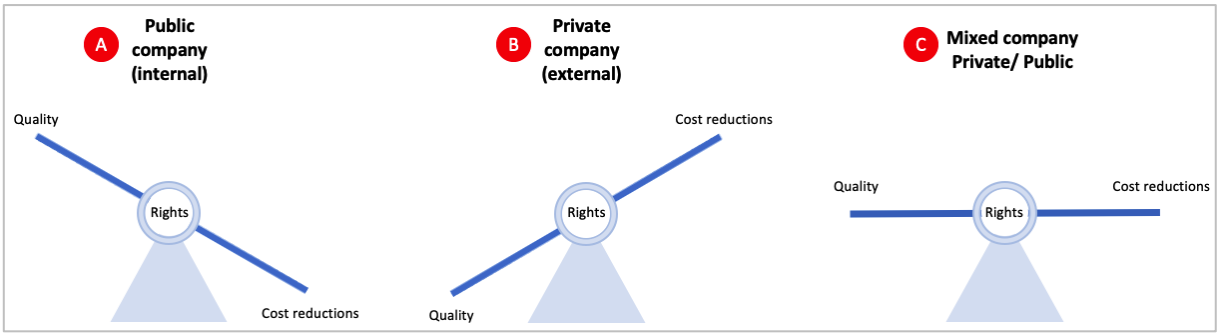


*Figure 1: The three basic forms of ownership according to Hart (Hart, Shleifer, and Vishny 1997)*

Figure 1 shows the basic ownership structure according to Hart. The influence of the division of residual control rights is shown by Hart on the basis of the following argumentation. On the one hand, a service can be provided by a public enterprise (A). This is characterized by a high willingness to invest in quality and a low intention to reduce costs. Since the residual control rights in this case lie with the state, the state employee needs the permission of the state as owner to reduce costs. The incentive to reduce costs is very low, unlike with the private-sector provider. The government employee receives only a fraction of the cost savings and is additionally replaceable. On the other hand, the service can be contracted out to a private sector company (B), this can be characterized with a strong incentive to reduce costs, to the point of reducing quality. This incentive exists because the company does not have to obtain permission from the contracting authority for cost-cutting measures if it has residual control rights. The

disadvantage of this is too high an incentive for negative quality reduction outside the contractable area (Hart, Shleifer and Vishny 1997, p. 1128 - p. 1129). Different factors come into play in the case of mixed company form (C), consisting of private and public providers. Hart states in his research that, depending on the type of public service to be provided, there are good reasons for internal provision or external provision of services. In general, Hart recommends that the consequences of poor noncontractual quality be weighed against those of potential noncontractual cost savings. If the consequences of poor, noncontractual quality are severe, and if innovation in quality plays a minor role or if there is corruption in government procurement, Hart recommends internal service provision with strong incentives for government employees if necessary. Hart recommends the second case, service provision by an external provider, for quality innovations in areas where clientelism or a very strong union organization is present. In this case, the danger of quality-reducing cost savings can be countered by contracts or competition (Hart, Shleifer and Vishny 1997, p. 1159).

# 3 Access charges and institutional change

As already mentioned at the outset, the European rail transport sector is subject to sector-specific regulation by the EU. In order to achieve the overarching goal of a single European internal market, four packages of measures (also known as railroad packages) were enacted between the years 2001 and 2016. These influence the design of the pan-European rail transport sector and significantly flank the process flows and company forms. As a comprehensive description of the railroad packages would exceed the scope of this paper by far, a short overview of the basic objectives and the most important guidelines influencing this study will be given. This is followed by a description of the process from ordering a train path, through allocation of train path capacity, to allocation of train paths in a vertically integrated railroad undertaking (see Figure 1). This is intended to provide a better understanding of the process as a whole, as well as a basis for classifying the current literature. Thus, a brief look into the internal process flows is provided. This is followed by a presentation of the four main groups

of company forms as well as a classification of the company forms into the specific law and residual rights according to Hart.

### 3.1 Sector-specific regulation in the rail transport sector

The most essential directives for the study are Directive 91 / 440 /EEC "on the development of the Community's railroads" from July 1991 (European Council 1991b), Directive 2012/34/EU "on the creation of a single European railroad area" (European Council 2012, p. 1) from November 2012 and its amendment by Directive (EU) 2016/2370 from December 2016 (European Council 2016).[4]

Directive 91/440/EEC laid down a basic framework for the market-based operation of the railroad sectors, which until then were still largely state-owned. This included, among other things, the recommendation to separate rail transport services and the operation of rail infrastructure, but minimally required the separation of accounting and administration of the companies as well as non-discriminatory access to the rail infrastructure throughout Europe for all companies. In order to allow the companies to be independent in a market economy environment, the companies should have a healthy financial structure (without legacy liabilities). On the basis of Directive 91 / 440 /EEC, numerous European nation states took action and restructured the national rail sectors (European Council 1991a). In the years 2001 to 2016, a total of four legislative packages (railroad packages) were adopted by the Council and Parliament of the EU (European council and Council of the european Union 2022). Directive 2012/34/EU is part of the recast of the first railroad package of the EU and almost the three directives[5] of the first railroad package together and replaces them. The recast to the first railroad package closed existing gaps in the legal framework and defined previous ambiguities in the legal texts. The overall objective of Directive 2012/34/EU was to improve quality for customers by increasing competition, to strengthen market supervision and to improve the basic framework conditions for investment projects. The Directive had an impact on the development

[4] At this point, only a selection of directives is explained that have a direct impact on the corporate form of the railroad sectors.

[5] Directive 2001/12/EC on the development of the Community's railroads (European Council 2001a)
Directive 2001/13 /EC on the licensing of railroad undertakings (European Council 2001b)
Directive 2001/14/EC on the management of railroad infrastructure European Council 2001c)

of corporate forms in that railroad undertakings with a dominant market position must act independently in terms of organization and decision-making. To ensure independence, the legislator requires separate accounting. Protective measures to ensure the impartiality of rail infrastructure companies must also be ensured in other core processes such as train path pricing, traffic management, capacity allocation and maintenance planning.

In November 2012, Directive 2012/34/EU was amended by Directive 2016/2370, which amended the Directive in the areas of opening the rail passenger market and the management of railroad infrastructure (Publications Office of the European Union 2016). In particular, the selection of different organizational models for the member countries ensures a wide choice of national forms of enterprises. The directive allows from "...full structural separation to vertical integration..." (European Council 2016, p. 2, Point 7) any form of enterprise. Furthermore, non-discriminatory access to tracks and stations is stipulated, regulatory authorities are strengthened and obstacles to competition (access to service facilities and services, framework agreements, cost calculation of train operations, etc.) are removed.

### 3.2 Train path capacity allocation process

Before the various corporate models can be classified and grouped according to Hart, a basic description of the process is first required in order to better understand the subject matter at hand here as well as to facilitate the classification of the literature.

A train path is the planned temporal and spatial occupancy of a section of track (block) (Janicki 2016, p. 27). This means that there are always several trains on a long section of track. To ensure the necessary safety, the trains move at block intervals. A block is thus a firmly defined section of track in which only one train may be located (Adler 1990, p. 138; Pachl 2004, p. 6 - p.7, p. 265; Janicki 2016, p. 138; Hausmann and Enders 2017, p. 58).

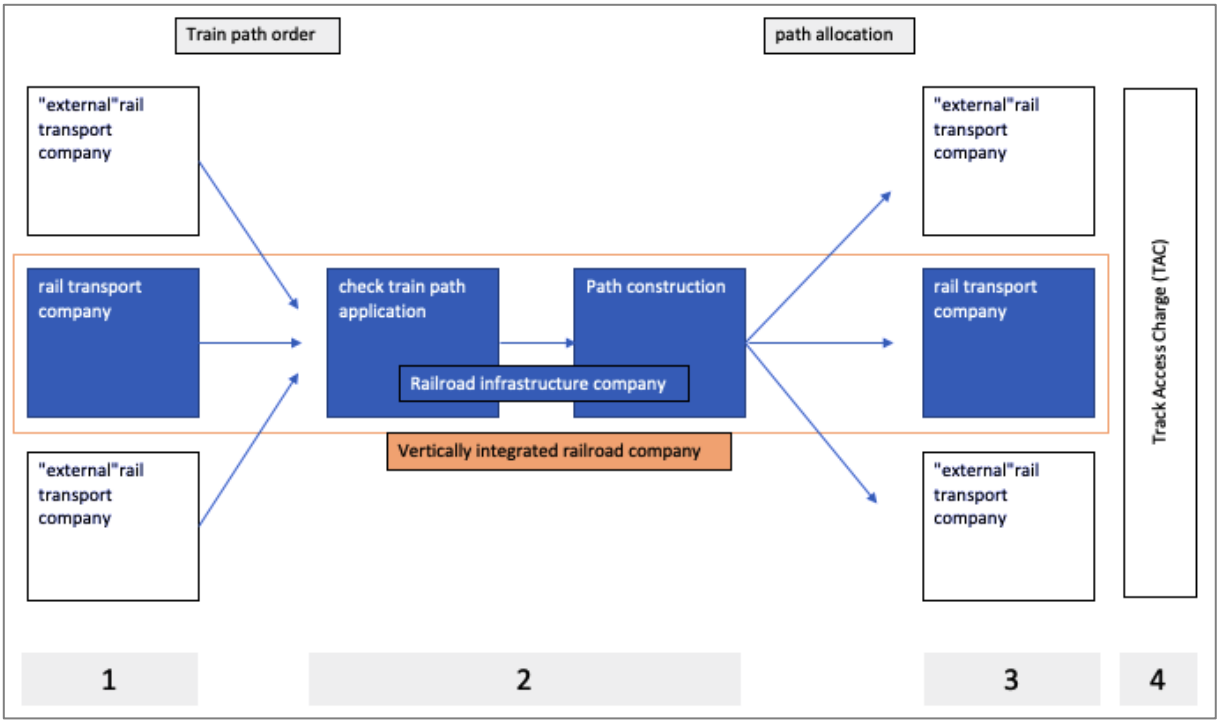


*Figure 2: Train path ordering and allocation process in Germany (own illustration according to DB Netz AG 2020)*

If a rail transport company wishes to use a route, it notifies the responsible rail infrastructure manager of the route and the desired departure time (Step 1, Train path order). The latter checks the route request and constructs the route for the railroad company (Step 2, Railroad infrastructure company). The train path is then allocated to the railroad undertakings placing the order (Step 3, path allocation). For the use of the ordered train path, the railroad undertaking pays the rail infrastructure provider a usage fee, the track access charge (Step 4, TAC) ) (DB Netz AG 2020). The different process steps will be used again in the presentation of the current literature (following chapter) to increase comprehensibility.

### 3.3 Organizational forms

The 28 countries included in the analysis were sorted into four main groups, which on the one hand ensures better comparability of the country groups with each other, but on the other hand always allows a certain degree of inaccuracy to enter into the analysis. Specifically, the historical development of each individual country under investigation was traced over the period under investigation. The focus was on the state-owned providers, which were historically formed mostly through the state-enforced merger of smaller private companies in the early 19th century. These providers can be characterized by vertical integration that encompasses the full process, as shown in Figure 2. Other characteristics are mostly a national dominant position and

mostly state funding.[6] All of these characteristics were also identified in the European legislator's guidelines described above. The grouping of the companies was based on the ownership structure and the integration of the parts of the company into the corporate structure. In order to enable comparability between countries, country-specific features such as company forms (stock corporations, limited liability partnerships, etc.) had to be aligned. The exact course of the company-internal dividing lines cannot be mapped with any degree of precision either. Thus, it is quite possible that the capacity allocation of train paths is located in one transport authority on the one hand, but that this is not the case within the same study group in another country.

In the following, the applied company forms are presented, as well as the ownership structure and classification of ownership rights according to Hart.[7] Starting with the most common type of company in Europe, (i.) the vertically integrated railroad company (Figure 3).

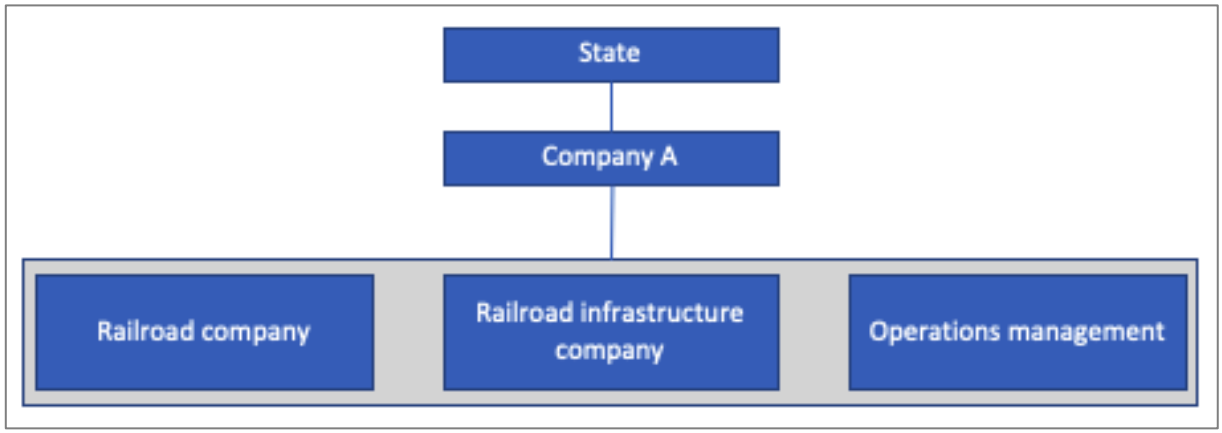


*Figure 3: Organization form 1 - vertically integrated company*

This type of company combines all the main components of rail operations under one roof. The holding parent comprises at least the rail transport company, the rail infrastructure provider and the operations management company. The rail transport company operates passenger and freight transport on its own rail infrastructure, consisting of signaling and track systems, among other things. The operations management corresponds to the "software" matching the "hardware" of railroad infrastructure. It is nothing less than the nerve center of rail traffic, and controls all traffic on the rail infrastructure. In short, the company can operate its completely

[6] There was no national market analysis involving "external" suppliers.

[7] The results of the study are summarized in Section 4.3.

own rail traffic. The study identified a total of 14 countries with this type of company, including Austria, Germany, Italy, Poland and Switzerland, among others.

All companies in this main group are fully owned by the state and therefore do not show any subdivision of specific and residual control rights. According to Hart, it can thus be assumed that the state, as the sole owner, pursues a long-term investment behavior that increases quality, but shows little cost-saving behavior due to a low incentive for state employees. There is little incentive after non-contractual cost savings and thus, as a consequence, little risk of non-contractual quality. Further, the historically grown corporate structure was retained in the included companies, thus no structural separation according to the European directives (91 / 440 /EWG, Directive 2012/34/EU, Directive (EU) 2016/2370) took place. Therefore, internal safeguards must be in place to ensure decision-making independence as well as to ensure non-discrimination in the essential core processes.

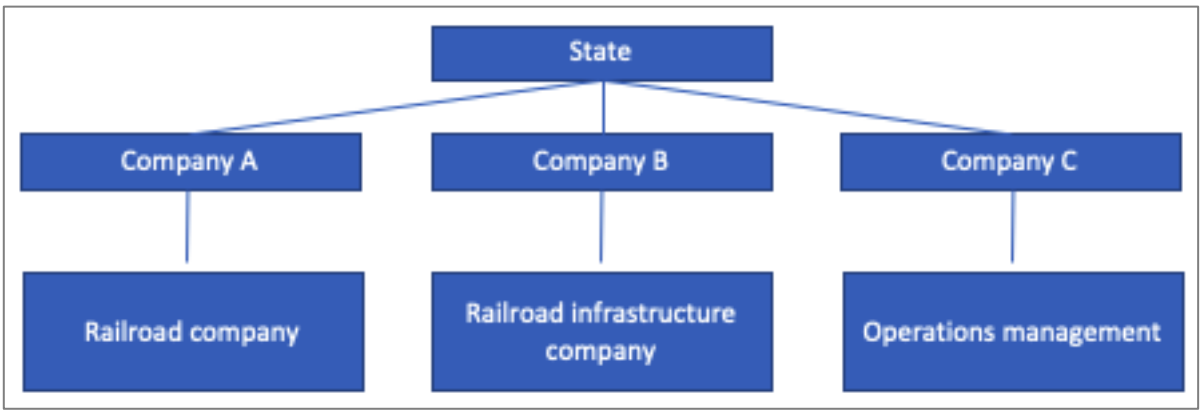


*Figure 4: Organization form 2 - disintegrated railroad transport company fully owned by the state*

Company form (ii.) (see Figure 4) describes a disintegrated rail transport company that is fully owned by the state. Due to its functional disintegration, this model meets the requirements of the EU and comprises an independent infrastructure manager, a rail transport company and a separate company for network management. There is thus complete functional separation between the individual stages of the value chain. Consistently throughout the study period (2011 to 2019), Belgium, Finland, Norway, Sweden, and Spain, among others, had this form of enterprise.

The distribution of specific rights and residual rights according to Hart does not take place in this form of enterprise, since ultimately all structurally separate enterprises are owned by the state. The long-term investment behavior with accompanying high quality can be assumed, as

can the low incentive to implement cost savings. According to European guidelines, the structural separation ensures independence and freedom from discrimination.

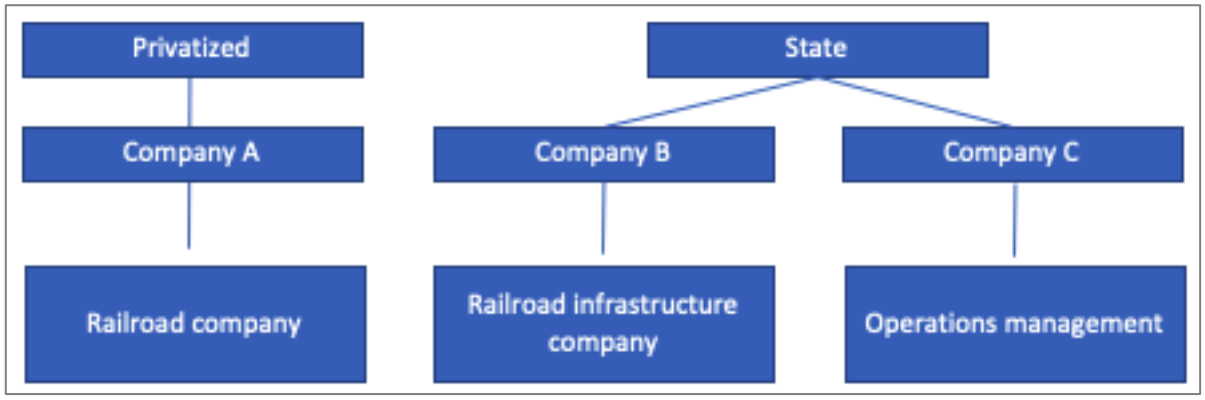


*Figure 5: Organization form 3 - vertically disintegrated railroad company with partial privatization in rail transport*

If we now take our thoughts one step further, we arrive at the step-by-step outsourcing of individual corporate divisions (see Figure 5). Company form (iii.) thus represents, in a sense, a further development of the previous company form. In partial privatization, the sale of different system components is conceivable. Privatization does not necessarily have to be limited to passenger or freight transport. However, if partial privatization is carried out in rail transport, and this affects only one of the two forms of transport, a partially integrated company continues to exist. Examples include Denmark, Hungary, the Netherlands, Portugal (from 2015) and Greece (from 2017).

Overall, this type of company represents a very interesting case according to Hart. The partial takeover of individual products (rail freight, local rail passenger transport, long-distance rail passenger transport) can take place either through the complete transfer of the (if any) specific rights and residual rights, or "only" through the acquisition of individual rights. Greece can be cited as an example here. Before the state railroad company TRAINSOSE was sold, the rolling stock was transferred to the Greek state (International Monetary Fund 2014, p. 200 - p. 201). . Thus, in the transferred sense, only specific rights in the form of transport contracts etc. were sold. At the same time, there was a minimization of non-contractual cost savings at the expense of safety in the rolling stock. Since rolling stock, rail infrastructure and traffic management have remained in state hands, according to Hart there is a high quality orientation with low motivation for cost savings.

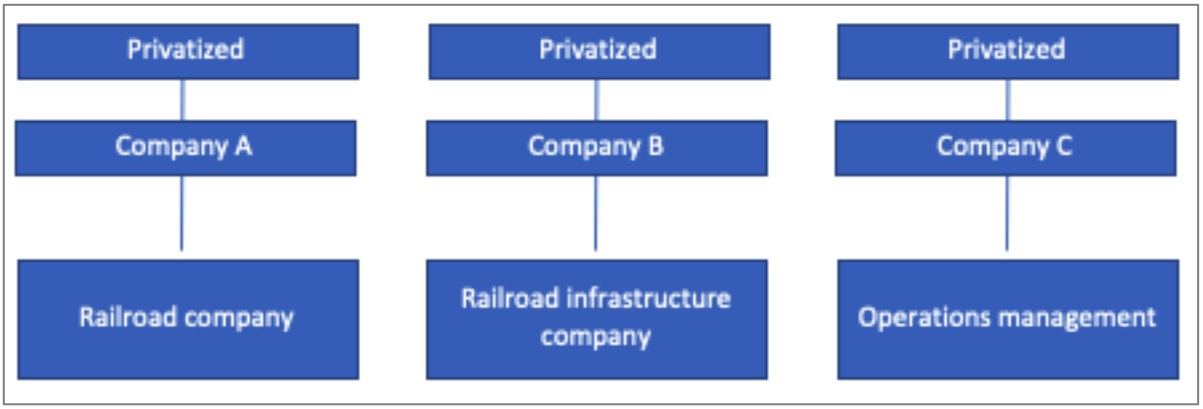


*Figure 6: Organization form 4 - fully privatized rail company*

Finally, and certainly one of the most famous examples in railroad history, is the (iv.) complete privatization of the entire railroad sector by breaking up the state monopoly altogether. As the only example in Europe, Great Britain can be mentioned, with unfortunately tragic consequences due to numerous serious accidents. In the United Kingdom, all specific rights and residual rights were sold in full.[8]

# 4 Literature

The current literature provides interesting focal points of investigation that have arisen as a result of the implementation of EU Directive 2012/34/EU and its subsequent amendment by RL 2016/2370, on the opening of the railroad market. In order to increase the connection of the current literature to our investigation, the present literature search will be oriented in the order of the process diagram from Figure 2 (process steps 1 to 4),.[9] This is to show in which of these process steps current research is available.

*Process step 1*

Casullo's study (2016) looks at the different providers of rail transport companies. In principle, a distinction can be made between two providers. On the one hand, there are the "traditional" fixed providers, which have been awarded a concession through a tendering process and offer and operate a fixed timetable over a longer period of time. On the other hand, there are so-called

[8] The example of Great Britain is taken up again in the summary of results.

[9] Process step 2 is a purely internal process, usually located at the railroad infrastructure company, for which there is no current literature. Nevertheless, it has been included in the process diagram for the sake of completeness and better understanding.

open access operators (OAOs), i.e. companies that bear the entire economic risk themselves and operate on routes that are not served by fixed providers through the award of concessions. OAOs thus represent additional competition to the formerly state-owned providers, and would thus be located in process step 1. In this context, this form of railroad operation has only become possible due to the opening of the railroad market. The connection to our study is that Casullo is examining the transition from company form 2 (disintegrated rail transport company under full state ownership) to company form 3 (vertically disintegrated rail transport company with partial privatization in rail transport). OAOs can operate detached from heavy state structures, and realize efficiency gains through modern trains, the omission of overpriced stations or in personnel costs. In the long-distance market, the market share is now about 30%. Casullo examines the impact of additional market entry on industry efficiency. The regression model is based on a difference-in-difference (DID) estimator and compares the periods of 2012-2013 with those of 2007-2011. As a result, Casullo identifies a 20 percent difference in operating costs per train kilometer (Casullo 2016). In the context of our study, Casullo's results show that partial privatization (company form 3) can indeed enable enormous efficiency benefits in passenger rail transport as well. However, it should be borne in mind that, as part of the provision of services of general interest, uneconomical stations and regions must also be operated, which in turn is likely to be at the expense of the efficiency benefits gained.

The studies by Montero and Bougette, Gautier and Marty (2019) also belong to the first process step. Both studies deal with entry requirements for potential competitors wishing to enter the market following implementation of EU Directive 2012/34/EU. The question is whether it would be pro-competitive if potential competitors in the rail transport market were granted preferential market access (asymmetric network access).

Montero is skeptical about the demands of some EU countries for asymmetrical network access for new competitors. The structural measures and codes of conduct imposed by EU Directive 2012/34/EU leave no room for asymmetries between different competing networks. Montero therefore recommends that the economic literature be taken into account, and that fragmentation of the European railroad area not be allowed (Montero et al. 2019).

Absolutely opposite to this, Bougette, Gautier, and Marty argue for asymmetric network access for competitors willing to enter the market. They argue that while on the one hand network operators have been obliged to grant competitors access to essential facilities, on the other hand there are nevertheless often discriminatory actions that are usually settled through settlements. However, these settlements cannot guarantee non-discriminatory access as a permanent

measure and thus enable competitors to operate reliably. Therefore, the authors call for asymmetric and permanent *ex ante* regulation. As a comparison, they cite the successfully liberalized telecommunications sector, where asymmetric access was also initially allowed for new competitors (Bougette, Gautier, and Marty 2021).

*Process step 3*

Ait Ali and Eliasson deal with the process of capacity allocation after implementation of EU Directive 2012/34/EU. The authors consider this process step to be elementary. They argue that even if a rail transport company offers the most favorable price for a tender within the EU, it is not clear whether this company will ultimately be awarded the train path. If several rail transport companies apply for a train path, there must be a transparent process of capacity allocation. Ait Ali and Eliasson demonstrate that this is not the case in most EU countries. In addition, in many EU countries, capacity allocation is done by the infrastructure managers, who are themselves active in the market as vertically integrated monopolists. The authors recommend an independent body to allocate train path capacity so that monopolists are not incentivized to discriminate (Ait Ali and Eliasson 2019).

*Process step 4*

Since the infrastructure usage charge (track access charges (TAC)) levied is based on the country-specific train path pricing system (TPS), the following investigations are assigned to process step 4.

Odolinski and Boysen investigated the impact of maintenance time windows at high capacity utilization on marginal costs using a panel data set of the Swedish Transport Administration from 1999-2014. Their investigation is about the maintenance and servicing costs which are covered by the train track access charge. As a result, it can be stated that a detailed "breakdown" of the cost structures, taking into account the route density, would enable a more accurate track access charge calculation that is more oriented to the real costs of the railroad infrastructure managers. The impact for actual traffic could be enormous. More differentiated pricing would allow for fairer traffic management (Odolinski and Boysen 2019).

To address current developments in track access charging systems, Bucsky examines the impact of the noise-based track access charging system based on the "introduction of noise-differentiated track access charges (NDTAC)" and its impact on the interoperability of the rail freight market within the EU. This involves granting incentives to rail transport companies in

the form of credits on the track access charge. Bucsky concludes that since there are no overarching regulations for the entire EU, the EU is promoting a bifurcation of the market. Countries where companies can afford to retrofit old freight cars will win more tenders in countries where NDTAC has already been introduced. Competitors with old freight cars, on the other hand, will mainly be active in countries where NDTAC has not been introduced. In the long term, standards will be harmonized, but this may take another decade due to the long service life of rolling stock (Bucsky 2021).

Based on the current state of research, this study takes a completely different approach and examines the overall horizontal process rather than individual vertical process steps. This means that if the process representation in Figure 2 is taken as a starting point, it shows the corporate form of the vertically integrated railroad company that is predominant in Europe. The assumption is that due to the different times of national implementation of the railroad packages as well as the diverging scopes of national implementation, a variety of company forms have emerged. Our analysis examines to what extent further company forms exist in Europe and whether there is a significant correlation between track access charges and company form. If we also take into account that passenger rail transport accounts for 82 percent of total transport performance in Europe and that an average track access charge of EUR 4.50 per train path kilometer is paid in passenger rail transport, this results in a market volume for track access charges of EUR 17.03 billion.[10] Thus, even minor changes in track access charges have a massive impact on rail operators (Independent Regulators' Group - Rail 2021, p. 16, p. 20).
The presumed track access price differences of individual company forms could thus indicate an efficiency advantage through the implementation of the railroad packages. This enables recommendations for action for the subsequent steps of the national implementation projects towards a track access charge efficient approach.

[10] Figures as of 2019, based on the minimum access package.
Total train kilometer performance in Europe 4616 million train kilometers (tkm)
82% = 3785,12 Mio. tkm * 4,50€/ tkm = 17033,04 Mio. tkm (Passenger Services)
18% = 830,88 Mio. tkm(Freight Services)

# 5 Data

Directive 2012/34/EU for the first time called on European government agencies to conduct a common exchange of data, to develop uniform assessment principles for public service contracts, and to develop overarching guidelines (European Council 2012, point 25). For this purpose, the regulatory bodies within the EU have joined forces to form the Independent Regulators' Group-Rail (IRG Rail). The organization now comprises 31 states, with the chairman changing every year. The IRG-Rail was formally established on June 09, 2011 in Den Haag (BNetzA 2022). Each year, the association prepares, among other things, statements on current topics related to railroads and an annual market monitoring.

## 5.1 Track Access Charges

By consolidating IRG Rail's annual market monitoring report, a panel data set for the period 2011 to 2019 was identified (Independent Regulators' Group - Rail 2013; 2014; 2015; 2016; 2017; 2018; 2019; 2020; 2021). The calculation of track access charges was based on the sum of track access charge revenues of railroad infrastructure managers per country divided by the number of passenger rail track kilometers operated in the country. The minimum access package according to EU Directive 2012/34/EU (European Council 2012, Annex 2) was used as the basis for the calculations. The minimum access package comprises the most elementary services required to offer rail transport. These include, among other things, the right to use track capacity, switches or stabling facilities, the processing of submitted capacity requests, the allocation of capacity, etc.. Diagram 1 shows track access charge revenues of rail infrastructure managers for 2019 based on the minimum access package in Euro per train-kilometer.

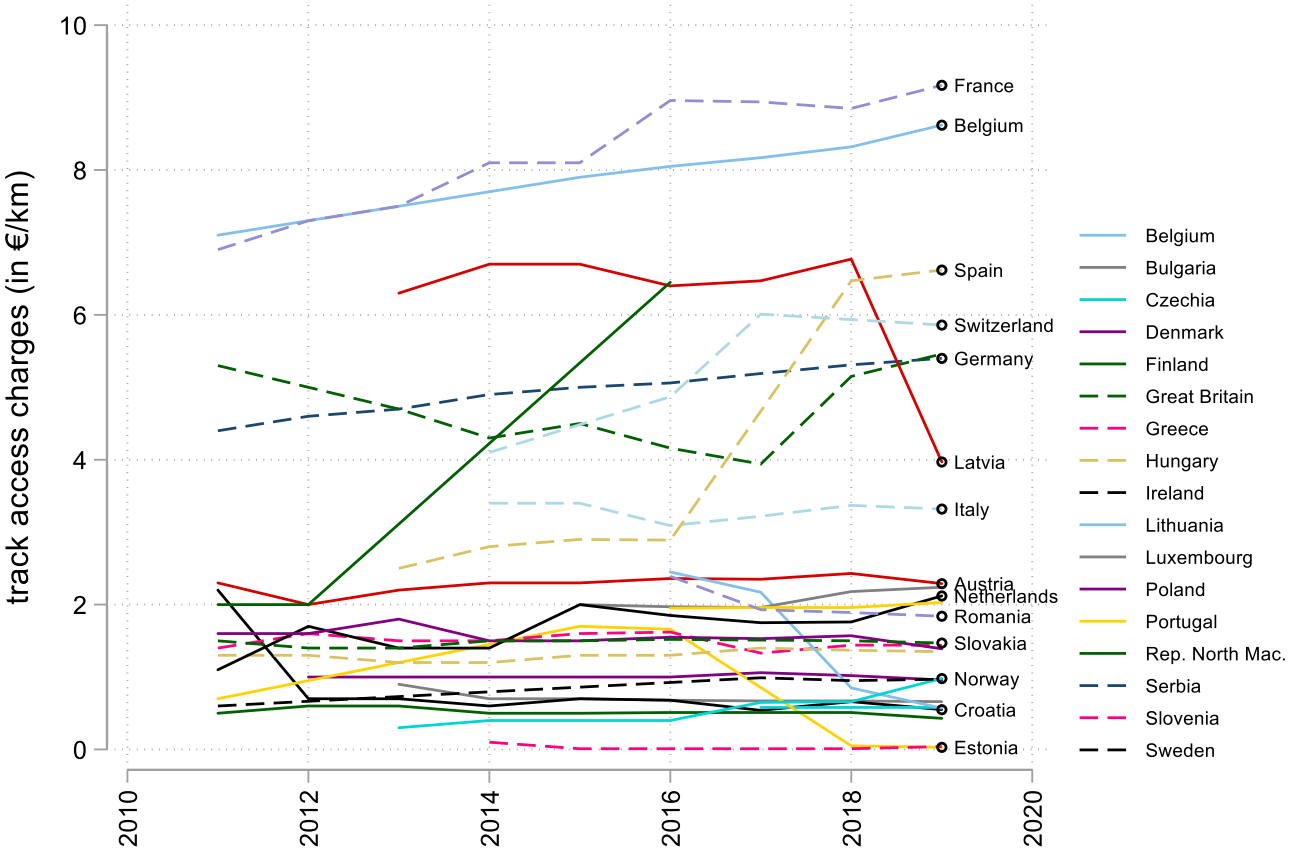


*Diagram 1: Track access charge revenue of the railroad infrastructure managers 2011-2019 for the minimum access package in Euro per train-kilometer*

## 5.2 Organizational form

For the empirical investigation of the form of companies, a disaggregation model was specially developed to distinguish individual dividing lines and to assign the ownership structure. As a result of the analysis of the 28 countries under investigation, the four main groups already described above could be identified and assigned to the respective countries. Particularly noteworthy are the countries with a change of corporate form during the period under review, including Croatia, France, Greece and Portugal.

| | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|---|---|---|---|
| Austria | | | | | | | | | |
| Belgium | | | | | | | | | |
| Bulgaria | | | | | | | | | |
| Croatia | | | | | | | | | |
| Denmark | | | | | | | | | |
| Estonia | | | | | | | | | |
| Finland | | | | | | | | | |
| France | | | | | | | | | |
| Germany | | | | | | | | | |
| Great Britain | | | | | | | | | |
| Greece | | | | | | | | | |
| Hungary | | | | | | | | | |
| Ireland | | | | | | | | | |
| Italy | | | | | | | | | |
| Latvia | | | | | | | | | |
| Lithuania | | | | | | | | | |
| Luxembourg | | | | | | | | | |
| Rep. of N. Macedonia | | | | | | | | | |
| Netherlands | | | | | | | | | |
| Norway | | | | | | | | | |
| Poland | | | | | | | | | |
| Portugal | | | | | | | | | |
| Romania | | | | | | | | | |
| Slovakia | | | | | | | | | |
| Slovenia | | | | | | | | | |
| Sweden | | | | | | | | | |
| Spain | | | | | | | | | |
| Switzerland | | | | | | | | | |
| | | | | | | | | | |
| | 1. Vertical integrated state own | | | | | 3. Partly privatized | | | |
| | 2. Unbundled state owned | | | | | 4. Full privatized | | | |

*Table 1: Result of the country surveys by form of company*

## 5.3 Governance Indicators

To reflect institutional change in the model, data sets from the Fraser Institute and the World Bank are used. The Fraser Institute index measures the degree of economic freedom through 5 principal components, which in turn are derived from 26 subcomponents and comprise a total of 44 variables. The principal components capture the size of each country's government, security of property rights and legal system, monetary policy and price stability, freedom of international trade, and regulation. For our analysis, we used only the regulatory factor component. The regulation factor specifically examines credit market regulation, the labor market, and business regulation (Fraser Institute 2021). The Worldwide Governance Indicators (WGI) from the World Bank was used as a second indicator. The indicator incorporates 6 main components. More weight is given to the political system and prevailing stability in countries. This can be derived from the components "voice and accountability" and "political stability and absence of violence/terrorism" and "rule of law," among others. Only the components measuring government effectiveness, regulatory quality and susceptibility to corruption seem more in line with an economic point of view. The WGI represents a whole-of-government approach to security (The World Bank 2021).

### 5.4 Modal Split Bus

The modal split indicates the percentage share of the respective mode of transport in the total domestic traffic of a country. The European statistical authority takes into account the modes of transport car, bus and train in the data basis. Basically, the movements within a national territory are measured, regardless of the nationality of the vehicles. Eurostat points out in the data set that the data collection method for the modal split is not standardized within Europe. The data of the European statistical authority are publicly available (Eurostat 2021c).

Between these modes, long-distance bus transport is the largest substitute to long-distance public rail passenger transport. It is assumed that price-sensitive customers use the long-distance bus market as a substitute for public long-distance rail passenger transport (positive cross-price elasticity). The additional transport capacities offered by the long-distance bus market could thus have a reducing effect on the track access charge.

### 5.5 Gross domestic product

Gross domestic product is a unit of measurement of a country's economic performance within a defined period. It measures the goods and services produced domestically. The semi-finished products and services used to produce these goods (intermediate inputs) are deducted from this (Statistisches Bundesamt 2015; Eurostat 2022). It is assumed that there is a significant correlation between a positive overall economic development on the one hand, and track access charges in the vertically integrated group on the other. The increase in raw material costs during economic peaks, due to the increased demand for raw materials, can lead to rising track access charges as a result of increased maintenance and new construction costs in the rail infrastructure. As a data basis, the measurement of the gross domestic product at market prices of the European statistical authority (eurostat) was used (Eurostat 2014; 2022). The data are publicly available.

### 5.6 Track density

The Track density should be used as a factor to reflect the special features of the different infrastructures in terms of their extent and availability to the population. A high route density offers more comfort, due to shorter travel times, and thus makes rail-based passenger transport more attractive for users. The route density used for the model was calculated by the area size of the respective country in relation to the route length.

$$Track\ density = \frac{Track\ length}{Land\ area}$$

For the route lengths, data from the European statistical authority (Eurostat 2021b), the German Federal Ministry of Digital Affairs and Transport (BMVI 2019, p. 321; 2020, p. 321), and the Office of Rail and Road data portal (Office of Rail and Road 2020, p. 1) were used.

### 5.7 Population density

For the population density data, publicly available data from the european statistical authority (eurostat) and the World Bank were used (Eurostat 2021a; The World Bank 2022). Population density reflects the ratio between the number of citizens in a country and the available land area. Population density should be viewed closely with line density in this context. While line density measures the theoretically available supply through the presence of rail infrastructure, population density indicates the theoretically possible user density. Both factors are necessary for public rail transport to operate at all.

### 5.8 Oil price

In our study, the oil price is used as an indicator for the energy price, and therefore forms an interesting control instrument. First of all, it is generally assumed that the oil price and the price of traction current exhibit a correlation, albeit only a moderate one. This correlation has already been confirmed in an EU study (European Parliament 2014, p. 17). Fluctuations in the price of traction current always affect the consumers, i.e. the rail transport companies. In a vertically integrated group, there is thus an incentive to set the price for traction current higher on the one hand in order to disadvantage competition, and on the other hand, the higher traction current price also creates an incentive to support the internal rail transport companies through cross-subsidization. Since the market for traction current has already been opened up by the EU Commission since 2014 (EU-Commission 2013), it seems difficult to disadvantage competitors in this segment. As a result, track access charges are a possible way forward. Thus, if the requirements of the EU legislator for internal safeguards against cross-subsidization have been met, there should be no significance between oil price development and track access charge, regardless of the company model.

Through the databases of the OECD (OECD 2021) and the EU Commission (EU-Commission 2019), a large part of the countries under investigation could be assigned to the respective oil price. Each country has a different oil price due to different taxes and levies.

| *Variable* | *Obs.* | *Mean* | *Stand. Dev.* | *Min* | *Max* |
|---|---|---|---|---|---|
| ***Dependent Variable*** | | | | | |
| *Track Access Charges* | 192 | 2.657 | 2.385 | .01 | 9.17 |
| ***Independent Variables*** | | | | | |
| *Organizational form* | 252 | n.a. | n.a. | 1 | 4 |
| *WorldGovernanceIndex* | 270 | 83.264 | 11.592 | 51.18 | 99.53 |
| *FraserInstitue* | 252 | 7.812 | .463 | 6.022 | 8.752 |
| *Modal split bus* | 252 | 11.618 | 5.018 | 2.7 | 26.5 |
| ***Control Variables*** | | | | | |
| *GDP* | 251 | 30991.076 | 21958.254 | 3660 | 100890 |
| *Track density* | 252 | .052 | .029 | 0 | .119 |
| *Population density* | 252 | 129.379 | 108.659 | 16.2 | 507.3 |
| *Oil price* | 170 | 77.236 | 26.232 | 40.1 | 115.6 |

*Table 2: Descriptive Statistics*

# 6 Model

We model track access charges as a function of competition, institutional quality, and the availability of substitute transportation while controlling for country-specific characteristics. In our model, we regress track access charges in a country $i$ in a year $t$ on a set of vectors of competition variables ($X_{it}$), institutional variables ($I_{it}$) and control variables ($C_{it}$). We also add dummy variables ($F_{it}$) to capture country specific fixed effects that allow for unobserved individual heterogeneity that is constant over time.

$$TrackAccessCharges_{it} = \alpha + \beta X_{it} + \gamma I_{it} + \delta C_{it} + \vartheta F_{it} + \varepsilon_{it}$$

It assumes that the individual-specific effects are correlated with the independent variables. A Hausman specification test confirmed this approach by showing significant differences between

the random effects estimator and fixed effects estimator (p= 0.1762), therefore the random effects assumption is rejected (Hausman 1978) and a fixed effects model is chosen.

Endogeneity of a country´s modal split and the dependent variable, track access charges might be suspected. High track access charges may lead to increased usage of substitutes (car, bus) and result in a modal split that reflects this. To account for this suspected endogeneity, we use the residuals of the prediction of the variable in a 2SLS-approach to the Durbin-Wu-Hausman test. We fail to reject the null hypothesis ($Prob > F = 0.5591$) and therefore find no evidence of endogeneity of these two variables. Furthermore, we check for multicollinearity in our model. Mean Variance Inflation Factors in our model are below $vif = 3.0$ with a vif of 2.166 ($1/vif = .462$) and 2.779 ($1/vif = .36$) on the two variables of concern. As this is well below the accepted econometric standard value, we do not support the concern of multicollinearity in the model.

# 7 Results

Table 3 presents the results of four linear panel regressions. It shows the estimated coefficient size, level of significance and standard error (in parentheses) of the estimated coefficient. Models (1) to (4) include various control variables as robustness checks on the coefficients.

| VARIABLES | (1)<br>Fraser Institute<br>(w/o controls) | (2)<br>Fraser Institute<br>(with controls) | (3)<br>WorldGovInd<br>(w/o Controls) | (4)<br>WorldGovInd<br>(with controls) |
|---|---|---|---|---|
| Company organization = 2, Unbundled state owned | -1.020*** | -1.100*** | -0.971*** | -0.961*** |
| | *(0.302)* | *(0.329)* | *(0.297)* | *(0.333)* |
| Company organization = 3, Partly privatized | -1.645*** | -1.810*** | -1.239** | -1.386*** |
| | *(0.533)* | *(0.453)* | *(0.499)* | *(0.435)* |
| Company organization = 4, omitted | - | - | - | - |
| fraserinst | 0.557** | 0.494** | | |
| | *(0.269)* | *(0.238)* | | |
| worldgovind | | | 0.0692*** | 0.0550*** |

| | | | | |
|---|---|---|---|---|
| | | | *(0.0214)* | *(0.0209)* |
| mode_bus | -0.126** | -0.234*** | -0.141*** | -0.243*** |
| | *(0.0535)* | *(0.0484)* | *(0.0528)* | *(0.0488)* |
| bip | | -6.16e-06 | | -1.69e-05 |
| | | (*2.79e-05*) | | *(2.89e-05)* |
| oilprice | | 2.74e-05 | | -0.000863 |
| | | *(0.00191)* | | *(0.00191)* |
| trackdens | | -53.45 | | -89.40* |
| | | *(45.17)* | | *(47.66)* |
| popdens | | 0.0519** | | 0.0807*** |
| | | *(0.0225)* | | *(0.0230)* |
| *Country-FE* | *YES* | *YES* | *YES* | *YES* |
| Year-FE | *YES* | *YES* | *YES* | *YES* |
| Constant | 0.190 | -5.475 | -1.253 | -7.499** |
| | *(2.207)* | *(3.579)* | *(1.904)* | *(3.734)* |
| Observations | 189 | 139 | 189 | 139 |
| R-Squared | 0.130 | 0.403 | 0.162 | 0.417 |
| Number of countries | 28 | 20 | 28 | 20 |

SE in parentheses; *** $p < 0.01$; ** $p < 0.05$; * $p < 0.10$.

*Table 3, Regression results*

The categorical variable *organizational form* shows a negative coefficient on the dependent variable that is highly significant (p=.001; p=.000 and p=.001; .014 resp. in models (2) and (4)). The average effect of a switch from a state-owned operator to an unbundled state-owned organizational form reduces the track access charges ceteris paribus by 1.10 Euro per trkm (model 2) and 0.961 € per trkm (model 4). Compared to the base group of fully state-owned, the organizational form of part privatization decreases the track access charges by 1.81 € per trkm (1.386 resp. for model 4). These effects are fully robust across models (see model (1) & (3)). Judging by these models, there appears to be a negative relationship with the degree of

privatization of the companies providing transportation service and the price of track access charges[11].

The variables that proxy institutional framework, *FraserInst* and *WorldGovInd,* significantly increase track access charges, even when controlling for mitigating factors *GDP* and *oil price*. The variable of *FraserInst* has a larger coefficient when compared to *WorldGovInd*, which is likely due to the nature of the index. In our dataset, the positive influence of *FraserInst* varies between 0.557** to 0.494* where *WorldGovInd* lays between 0.0692*** and 0.055***. Therefore, the larger coefficient does not mean it has a stronger impact on track access charges but rather is due to the more granular expression of *WorldGovInd*. Yet both have a positive relationship with the dependent variable.

The variables that capture substitutional effects between trains and means of individual transport as well as other public transports show mixed effects. The intensity of bus usage ceteris paribus highly signifcantly decreases track access charges ($\beta = -0.238***$ and $-0.244***$ resp.). *Oilprice* shows no significant effect on track access charges.

# 8 Discussion and Conclusion

Based on the results of our model calculation, we will conclude by answering the two research questions. Figure 7 shows the connection between the organizational form of the company, track access charges and the development of the ownership structure. The first two variables, organizational form and track access charges, are answered by the first research question. The connection between track access charges and ownership structure according to Hart (Figure 7, lower third - A, A, C, B)[12] is explained in the second research question.

(i.) Is there a correlation between company forms and track access charges?

Based on the results of the statistical model, there is a significant correlation between organizational forms and track access charges. Starting with the vertically integrated company form, the track access charge decreases continuously for the subsequent unbundled state-owned

[11] Due to the nature of the fixed-effects model, the FE estimator explains the variation in the dependent variable perfectly. All obersvations of this specific organizational form are attributed to one country (UK), therefore it is omitted by the model.

[12] The ownership structure is explained in chapter 2.3 (especially Figure 2 - A, B, C).

and partly privatized company forms. Since the fully privatized form of enterprise was excluded from the analysis due to insufficient measurement samples, it can only be assumed that the reduction in the track access charge would also continue in this form of enterprise. The correlation between company form and track access charge change is shown in Figure 8.

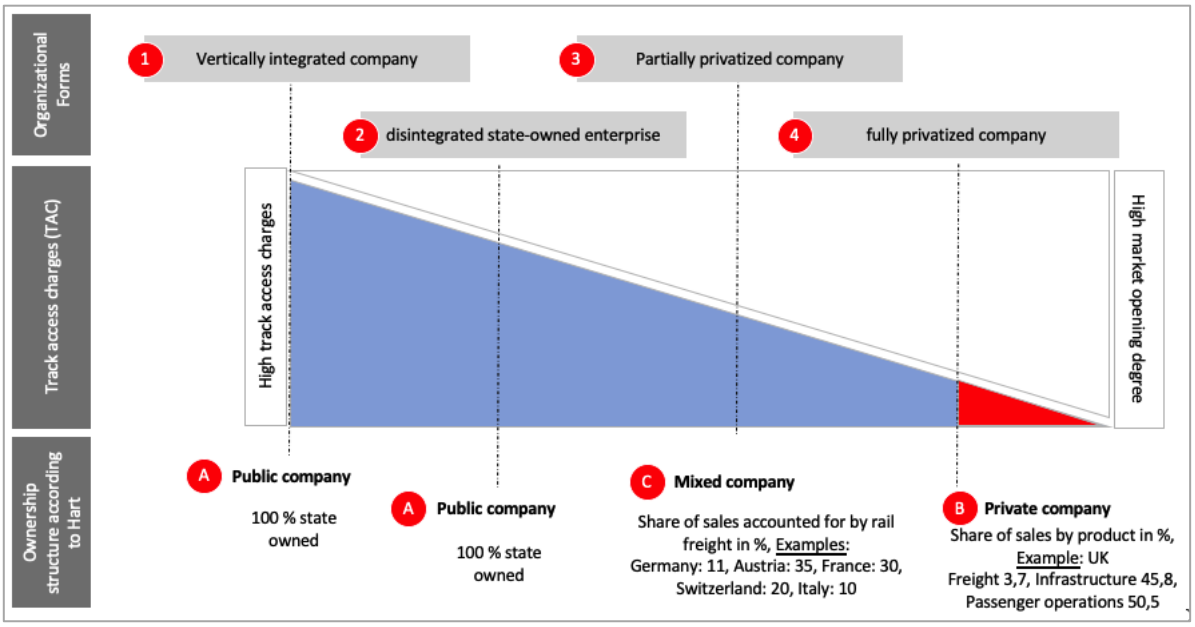


*Figure 7: Link between organizational form, track access charges, and ownership structure according to Hart (own illustration)*[13]

In the first stage of vertical disintegration in full state ownership (organizational form 2), efficiency gains are apparently increasingly generated by a sharp change in incentives. It can be assumed that efficiency-inhibiting behavior patterns are thereby dissolved. While the incentive to discriminate is in principle high in a vertically integrated group with a holding structure, the incentive situation changes for individual companies under direct state ownership. Management in the integrated group is influenced in its behavior by a profit-oriented incentive for the company as a whole. Individual companies under direct state ownership, on the other hand, have no incentive to behave in a discriminatory manner toward competitors. This change in behavior lowers potential barriers to market entry for competitors, which in turn leads to more competition on the rail network and thus to more transaction frequencies and lower

[13] The mixing ratios of the sample countries (mixed company) to obtain an indicator of optimal distribution between state and private ownership structure were calculated in Table 1 using the average revenue shares of the rail freight product for fiscal years 2011, 2015, and 2019. For the private company ownership structure, the revenue shares of the rail freight, rail passenger, and infrastructure product groups for 2018 were used.

transaction costs overall. One step that further accelerates market opening is the partial privatization (organizational form 3) of the disintegrated company. In this context, the initial EU legislation had a preferential effect on freight transport. The creation of overarching European freight highways, the so-called Trans-European Transport Networks (TEN-T), has increasingly liberalized freight transport. It is therefore hardly surprising that the privatization process has given priority to the freight transport segments. These effects may have led to the mostly loss-making former state-owned freight railroads being separated from the group, thus eliminating the cross-subsidization that is often suspected. Nevertheless, even a partially integrated company still has an incentive to discriminate against competitors, for example in rail passenger transport. Passenger rail transport plays a much greater role than freight transport in many rail nations in Europe (Independent Regulators' Group - Rail 2021, p. 20). As shown in Figure (8), there is also an area where privatization appears to reach its limits. In the model estimates, the company form of fully privatized companies was not considered due to the small sample size (one country). Nevertheless, there is a presumption that full privatization (organizational form 4), and there in particular the sale of rail infrastructure, can be described as a "cardinal mistake." On the one hand, this can be seen in the example of Great Britain, with many fatal accidents due to outdated infrastructure and overworked personnel, and at the same time drastically increasing ticket prices and decreasing quality. On the other hand, the development in Estonia also shows that a sale of the rail infrastructure (from 2001 to 2007) was accompanied by accidents and a complex and expensive repurchase process. The high continuous investment costs for the operation, maintenance and new construction of rail infrastructure can apparently only be borne by the state.

Since the level of infrastructure costs, among other things, ultimately also has an impact on the fare, long-distance bus companies have a decisive advantage here. Since no tolls will have to be paid for buses in Europe in the future, this competitive advantage is likely to be maintained in the near future (Weyh 2021). In order to be able to assess the competitive situation between rail-based passenger transport and the long-distance bus market, the transport performance share of buses was considered in our model. A correlation between the increasing traffic performance of buses and a diminishing effect on the dependent variable was found. It can be assumed that, due to a positive cross-price elasticity, price-sensitive users switch from cost-intensive long-distance passenger rail services to long-distance bus services. It is conceivable that a vertically integrated group reacts to the additional competition with "adjusted" track access charges in order to make its own service more attractive in terms of price.

Our model runs show a significant relationship between track prices and development factors. The Fraser Institute's Economic Freedom Index, which focuses on a country's regulatory activity, shows robust values across models 1 and 2. This also affects the robustness of the model calculation on corporate forms. There, robust values were also found for the "Unbundled state-owned" and "Partly privatized" forms of enterprise. The World Governance Indicator (WGI), which measures more broadly, also shows robust values for both types of company. Surprisingly, despite the differences in the content of the individual components of the two indicators, the results between the two development factors are small.

(ii.) Is there a relationship between track access charges and the development of the ownership structure?

As already shown in the answer to the first research question, the track access charge consistently decreases for the unbundled state-owned and partly privatized forms of enterprise, starting from the vertically integrated form of enterprise. For the fully privatized company form, the decreasing track access charge is assumed. However, Figure 8 shows another interesting relationship between decreasing train track access charges and the changing ownership structure. While the ownership structure between the vertically integrated company and the unbundled company remains unchanged at 100 percent state ownership, there is nevertheless a train path price reduction of 1.10 per trkm. But how can this be explained? In the case of structural separation, the companies (or the state) receive the residual rights back, while an exchange of services continues to take place due to procedural necessities on the basis of contract-specific rights. Since the residual rights remain with the state, the incentive distortion in governance described by Hart is eliminated, which in turn has implications for investment behavior, efficiency and quality. In this case, since there is no "imbalance" in control rights and compensation power, existing investment distortions decrease. Thus, the decreasing track access charges between the vertically integrated form and the unbundled corporate form show an increase in efficiency due to decreasing investment distortions. According to Hart, the optimal ownership structure exists where these distortions are lowest. Thus, the reduction in track prices between the two enterprise forms indicates a more optimal ownership structure. When the form of enterprise is changed further, to a partially privatized enterprise (form 3), the state's share in the previous, structurally separate enterprise (form 2) is reduced for the first

time. Based on a vertically integrated company form, it can be seen that partial privatization appears to further optimize the ownership structure. The train path price reduction between the vertically integrated and the partially privatized company is 1.81 per trkm. According to Hart, this form of enterprise apparently leads to an even smaller investment distortion and thus to an associated increase in efficiency.[14] Overall, partial privatization turns the rail transport sector, which was previously in purely public hands, into a mixed company. Even if the company as a whole remains in public hands and only one part of the company is privatized, it can be assumed that specific contractual rights will continue to ensure the provision of services between the private and public parts of the company. In most cases, market shares are simply too high for a complete bypass of a formerly state-owned product provider (e.g., in rail freight transport). The privatizations observed affected a total of 5 of the 28 countries under review. [15] Since all partial privatizations are in the rail freight product, the authors used 5 rail transport sectors still in organizational form 1 (vertically integrated) to determine the average revenue share based on fiscal years 2011, 2015, and 2019 (see Table 4 below). The average values for the financial years of the individual countries were also rounded and included in Figure 8. Based on the calculated values, an average revenue share of 21.19 percent can be indicated (see Table 4 below). This share can provide an initial indicator to determine the "optimal mix ratio" towards the lowest investment bias and thus the optimal ownership structure. This approach also provides opportunities for further research on the relationship between revenue shares and track access charges and overall efficient behavior in the national rail sectors.

[14] Friese, Heimeshoff and Klein find for the German waste collection sector that private provision is the most efficient. Mixed forms, so-called public-private partnerships (PPP), show lower efficiency than purely public facilities (Friese, Heimeshoff, and Klein 2020). Since rail passenger transport in Germany also falls under public services, our result contrasts strongly with Friese, Heimeshoff and Klein.

[15] Countries that have been partially privatized are: Greece (Rail freight transport), Netherlands (Rail freight transport), Portugal (Rail freight transport), Denmark (Rail freight transport) and Hungary (Rail freight transport). It was not possible to determine the sales ratios for the period under review to determine the Rail freight transport share of sales. Therefore, vertically integrated companies were used.

| Country | Company Name | 2011 | 2015 | 2019 | Average |
|---|---|---|---|---|---|
| Germany | DB Cargo | 12,99% | 10,19% | 9,43% | **10,87%** |
| Austria | Rail Cargo Austria | 40,13% | 32,43% | 33,23% | **35,27%** |
| France | SNCF Geodis | 29,18% | 30,96% | 28,49% | **29,54%** |
| Switzerland | SBB Cargo | 21,99% | 20,01% | 18,79% | **20,26%** |
| Italy | Ferrovie dello Stato Italiane | 11,94% | 11,14% | 7,01% | **10,03%** |
| | Annual Average | 23,25% | 20,95% | 19,39% | |
| | **Average** | | **21,19%** | | |

*Table 4: Determination of the share of rail freight transport in total turnover* [16]

As described above, the fully privatized form of enterprise could not be included in the model due to the small sample size. The authors suspect an additional reduction in the track access charge. Based on data collected by the Office for Rail and Road, it was nevertheless possible to determine the product-dependent revenue shares for the English rail transport sector. The shares are 4.1 percent for rail freight, 58.7 percent for passenger services, and 37.2 percent for the infrastructure provider Network Rail (Office of Rail and Road 2020b, Figure 1, p. 4). The low share of rail freight is likely due to the overall weak integration of the U.K. into the pan-European rail network. The overall development of the British rail transport sector after privatization shows the disproportionate incentive of private operators to achieve non-contractual cost savings by lowering quality in a non-contractual manner. Starting from Hard, in the rail infrastructure sector, the presence of a single private sector provider meant that quality reductions could not be corrected through competition, ultimately leading to serious accidents. The concession model used for passenger rail transport was also unable to prevent quality losses through competition.

Finally, it should be borne in mind with regard to the data basis that the share of infrastructure costs is assumed to be constant for all countries investigated. As a component of infrastructure

[16] (Deutsche Bahn AG 2011, p. 105; 2015, p. 182; 2019, p. 101), (ÖBB Holding AG 2011, p. 29; 2015, p. 62; 2019, p. 64), (Société nationale des chemins de fer français 2012, p. 1; 2015, p. 13; 2019, p. 20), (Schweizerische Bundesbahnen AG 2011, p. 93; 2015, p. 84; 2019, p. 74), (Ferrovie dello Stato Italiane 2011, p. 137; 2015, p. 192; 2019, p. 266)

costs, the track access charge certainly accounts for the largest share. The track access charge calculation of the individual countries is not uniformly regulated within the EU. On the one hand, technical factors can have an effect, on the other hand, delimitation differences between track access charge and station costs can arise. One effect, which also cannot be quantified individually for all EU countries, is that of government subsidies and grants. Track access charges can be influenced by government subsidies in the short term or in the long term. Investment funds for infrastructure measures can also influence track access charges.

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# 10 Appendix

## Variance inflation factors

### Model 2

| | VIF | 1/VIF |
|---|---|---|
| 2.Organizational form | 1.535 | .651 |
| 3.Organizational form | 2.264 | .442 |
| 4.Organizational form | 1.41 | .709 |
| fraserinst | 1.706 | .586 |
| bip | 2.041 | .49 |
| oilprice | 1.069 | .936 |
| trackdens | 3.546 | .282 |
| mode bus | 2.166 | .462 |
| popdens | 3.898 | .257 |
| Mean VIF | 2.182 | . |

### Model 4

| | VIF | 1/VIF |
|---|---|---|
| 2.Organizational form | 1.559 | .641 |
| 3.Organizational form | 2.207 | .453 |
| 4.Organizational form | 1.354 | .739 |
| worldgovind | 5.053 | .198 |
| bip | 3.741 | .267 |
| oilprice | 1.073 | .932 |
| trackdens | 3.248 | .308 |
| mode bus | 2.779 | .36 |
| popdens | 3.821 | .262 |
| Mean VIF | 2.759 | . |

Table 5 & 6: variance inflation factors

## Correlations

| Variables | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
|---|---|---|---|---|---|---|---|---|---|
| (1) imr | 1.000 | | | | | | | | |
| (2) Organizational form | -0.082 | 1.000 | | | | | | | |
| (3) fraserinst | 0.073 | 0.208 | 1.000 | | | | | | |
| (4) worldgovind | 0.163 | 0.257 | 0.631 | 1.000 | | | | | |
| (5) bip | 0.283 | 0.282 | 0.529 | 0.838 | 1.000 | | | | |
| (6) oilprice | -0.016 | 0.008 | -0.119 | 0.112 | 0.025 | 1.000 | | | |
| (7) trackdens | 0.484 | -0.127 | 0.370 | 0.328 | 0.269 | 0.090 | 1.000 | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| (8) mode_bus | -0.345 | -0.387 | -0.414 | -0.734 | -0.632 | -0.014 | -0.272 | 1.000 | |
| (9) popdens | 0.356 | 0.354 | 0.301 | 0.380 | 0.366 | 0.041 | 0.689 | -0.512 | 1.000 |

Table 7: correlations