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The Impact of Vertical Separation on the Success of the Railways

This paper empirically analyses whether full ownership separation strengthens rail in comparison with other transport modes – a major goal of European and national transport policies. Data from nine European countries in the period 1994-2009 are evaluated, with the end result that the positive effects of full separation cannot be confirmed. On the contrary, full separation significantly reduces the share of rail in passenger transport, while in the freight segment, the regressions yield ambiguous results.

Ever since the scheduling of railway reforms across Europe and worldwide, the question of whether or not an operator of rail infrastructure should be allowed to provide rail transport services as an "integrated company" has been subject to political and scientific debate. At present, it is again being discussed intensely at the European level. One reason for this is that the European Commission has initiated infringement proceedings against several member states for failing to implement the "separation model", which – according to the European Commission – is required by European law.[1] A second cause is that advocates of the separation model have called for a modification of the unbundling provisions within the so-called recast of the First Railway Package, which is currently in the legislative process. Third, the European Commission has announced a new initiative to enforce the existing unbundling provisions if the treaty violation proceedings should not come to a result that is satisfactory from the Commission's point of view.

It is appropriate to clarify at the outset that the labels "separation" and "integration" fall short of the actual situation in Europe. With the exception of Ireland and Northern Ireland, all member states of the European Union have implemented railway reforms, including various unbundling measures, which render the railways to some extent "separated". Furthermore, there are a variety of different approaches. However, for the sake of simplicity, we adopt the European Commission's classification[2], which differentiates between the full (ownership) "separation model" (OS), the "holding model" (HM), where the infrastructure manager and at least one train operating company are associated under the umbrella of a holding company, and a "hybrid model", where the independent infrastructure manager has delegated functions to one train-operating company.[3]

The principal motivation for the cited initiatives at the European level is to foster rail in absolute terms and in comparison to other transport modes. Separating infrastructure from transport is an adequate means if the advantages of vertical separation outweigh potential disadvantages. So far, however, there is little empirical evidence to indicate whether this trade-off favours full separation in the railway sector. For the initiatives to be successful, it is therefore crucial to provide compelling empirical evidence which substantiates the benefits of separation. This paper aims at contributing to fill this gap.

However, the main result of our econometric panel data analysis, which exploits data from nine European countries in the period 1994-2009, is that there is no evidence to support the separation model. In passenger transport, the results even indicate that countries which adopted the separation model are significantly worse off than

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1 European Commission: Accompanying Document to the Report from the Commission to the Council and the European Parliament on Monitoring Development of the Rail Market (COM(2009)676 final/2), http://eur-lex.europa.eu/LexUriServ.do?uri=SEC:2009:1687:REV1:IN:PDF, 2010 (downloaded on 29.8.2011), pp. 8-12.
2 Ibid., p. 18.
3 The European Commission introduced an additional fourth category in 2010, which contains countries and regions whose railways are still fully integrated (Ireland and Northern Ireland). Neither is included in our sample.

countries which preserved an integrated structure. In the freight segment, no robust results can be obtained. Our main conclusion is, therefore, that the current initiatives to separate ownership of rail transport and infrastructure management are premature – and perhaps even counter-productive.

By contrast, another result of our analysis encourages one of the Commission's initiatives: liberalisation seems to have a positive impact on the performance of rail. This result supports the European Commission's plan to liberalise the still partially closed national rail passenger transport markets.

Our ambiguous results as to the effects of full separation in the freight segment call for further research. The regressions indicate that factors neglected by our approach play a role in this segment. The inclusion of more countries and a longer observation period could also increase robustness. Thus, one further conclusion from our analysis is that further research is indispensable in order to validate the results and to render an evidence-based policy possible.

Theoretical and Institutional Background

Historically, railways developed as integrated firms enjoying national or regional monopolies. Competition between railways played virtually no role. But in contrast to the infrastructure, in particular the railway network, which displays the characteristics of a natural monopoly, competition in downstream rail transport markets is feasible in principle. Beginning with the United Kingdom in the early 1990s, governments throughout Europe implemented reforms of the legal and institutional framework of the railway sector. One goal was to stop the downward trend of rail in many countries. Competition in the downstream markets was introduced as a means to increase customer orientation and cost efficiency. Unbundling measures were implemented in order to render fair competition possible. Independent of the structural model chosen, no train operating company should be allowed to influence decisions of the infrastructure manager regarding the so-called "essential functions", in particular the allocation and pricing of slots. Apart from unbundling the inherently monopolistic infrastructure and potentially competitive transport services, regulatory regimes have also been introduced. Details of the reforms have been quite different, though. While some countries, such as the United Kingdom and Sweden, separated the two divisions completely, other countries introduced various measures, including organisational and legal unbundling and the separation of

accounts, in order to safeguard the neutrality of the infrastructure, while preserving ownership integration of the incumbents.

The most important argument for a *complete separation* of infrastructure and transport companies is that it is expected to enhance competition. If a firm controls the railroad network (upstream), proponents of separation suspect, it may discriminate against its competitors in passenger or freight transport (downstream) to obtain a competitive advantage. Opportunities for discrimination exist not only regarding the price that train operating companies must pay for access to the infrastructure but also in other dimensions, such as the infrastructure manager's readiness to comply with the needs of train operating companies in the case of a disruption. Regulatory rules and institutions to restrict discrimination are necessarily incomplete and differ across countries. Furthermore, even without any actual discrimination, the mere possibility of discrimination may suffice to hamper market entry. Therefore, so the argument goes, complete separation would contribute substantially to intensifying competition on the tracks. End customers of rail transport – passengers, forwarders and contracting authorities – would benefit from this increase in competition through lower prices, higher quality and greater customer orientation. This would increase the attractiveness and market share of rail, which is a declared goal of European and many national transport policies.[4]

The most important argument against initiatives to make full ownership unbundling mandatory is that the holding model generates cost advantages. These advantages arise from synergies and lower transaction costs between the operation of infrastructure and transport, the avoidance of separation costs and the internalisation of otherwise external effects. Some of these benefits are explored in the literature on transaction costs, following the seminal work of Williamson[5], and have been applied to several network industries, including the railways.[6] The alliance with rail transport companies, which are in fierce competition with road transport in particular, would create incentives for the infrastructure manager to provide services of the quality requested by the markets and as efficiently as possible. Investment decisions would be more

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4 European Commission: White Paper: Roadmap to a Single European Transport Area: Towards a Competitive and Resource Efficient Transport System, COM(2011) 144 final, 2011, p. 9.

5 O. E. Williamson: Markets and Hierarchies: Analysis and Antitrust Implications, New York 1974, Free Press.

6 See G. Friebel, A. Gonzalez: Vertical Integration, Competition and Efficiency, Rapport 10, 2004, IDEI; and R. Pittman: Structural Separation to Create Competition? The Case of Freight Railways, in: Review of Network Economics, Vol. 4, No. 3, 2005, pp. 181-196, and the literature quoted therein.

oriented towards the needs of transport companies as well. In consequence, the entire rail sector and taxpayers would benefit from the holding structure. The described advantages would render the sector more competitive in comparison with other means of transport, which raises the market share of rail. Regulatory authorities that are vested with all necessary competencies would be able to ensure that access to infrastructure is not hampered by discriminatory practices.[7] Figure 1 depicts both parties' main lines of reasoning.

Both parties also have several additional arguments to the ones reported here thus far.[8] For example, it is claimed that separation increases transparency with regard to the financing of infrastructure and other activities that are (partially) supported by the government. Separation would also be a step towards a single European transport area[9], since separated infrastructure managers could co-ordinate more easily. On the other hand, among other things, economists point to the so-called double marginalisation effect. The negative effect of monopoly prices at the upstream level would be amplified by incomplete competition at the downstream level in the case of vertical separation.[10] Furthermore, ownership integration is supposed to impact positively on the firms' propensity to invest in the infrastructure, which may (partially) alleviate the national governments' tight financial situation. This contribution does not assess the validity of these – and other potential – arguments. Instead, we start our analysis by noting that at the core of each party's reasoning is the claim that its preferred structure would enhance the competitive position of rail relative to other modes of transport.

Neither position can be rejected *a priori*. The decisive question is thus whether or not the advantages of potentially more competition in the case of vertical separation outweigh the alleged cost advantages of the holding.[11] This is a genuinely empirical question. Advantages of both models must be substantiated by means of comprehensible measures. This paper tries to answer this

Figure 1

The Main Lines of Reasoning in the Debate on Vertical Separation
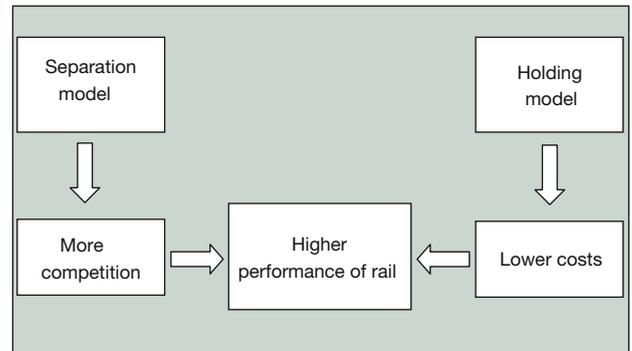
question by econometrically analysing the impact of the organisational structure on the modal share of rail, which serves as a summarising measure for the attractiveness of rail services.

Existing empirical literature on the effects of separating railway infrastructure from transport services is rare and inconclusive. Friebel, Ivaldi and Vibes[12] show that the institutional reforms of the railways in Europe generally increased productivity in the period 1995-2000. Their results suggest that reforms tend to yield better results if they are carried out sequentially rather than in a big bang. In a comprehensive study covering 16 European countries in the period 1985-2004, Cantos Sánchez, Pastor Monsalvez and Serrano Martinez[13] determine that vertical separation enhances productivity, in particular if transport activities in different segments are also separated from each other. Driessen, Lijesen and Mulder's[14] results on the effects of competition on productive efficiency are ambiguous. Growitsch and Wetzel[15] find evidence in support of the view that the holding structure has advantages in terms of efficiency. Examining the US railway markets, Ivaldi and McCullough[16] establish that running infrastructure and freight transport separately increases costs by

7   See e.g. R. Pittmann, op. cit.

8   See e.g. M. Ksoll: Integration of Infrastructure and Transport: An Assessment from Industrial Economics and Railway Perspectives, Paper presented at the 2nd conference on railroad industry structure, competition and investment, Evanston (Ill., USA), October 8/9, 2004 for a more comprehensive discussion of the pros and cons of a (partially) integrated structure in the railway sector.

9   European Commission: White Paper…, op. cit.

10 See e.g. P.L. Joskow: Vertical Integration, in: C. Menard, M. Shirley (eds): Handbook of New Institutional Economics, Dordrecht, the Netherlands 2005, Springer.

11 See e.g. OECD: Structural Reform in the Rail Industry, Competition policy roundtables, 2005, p. 9 and G. Friebel, M. Ivaldi, J. Pouyet: Competition and Industry Structure for International Rail Transportation, IDEI Working Paper, No. 680, July 2011, p. 3.

12 G. Friebel, M. Ivaldi, C. Vibes: Railway (De)Regulation: a European Efficiency Comparison, in: Economica, Vol. 77, No. 305, 2010, pp. 77-91.

13 P. Cantos Sánchez, J.M. Pastor Monsalvez, L. Serrano Martinez: Vertical and Horizontal Separation in the European Railway Sector: Effects on Productivity, Working Paper No. 201065, 2008, Fundacion BBVA/BBVA Foundation.

14 G. Driessen, M. Lijesen, M. Mulder: The Impact of Competition on Productive Efficiency in European Railways, CPB Discussion Paper No. 71, 2006.

15 C. Growitsch, H. Wetzel: Testing for Economies of Scope in European Railways: An Efficiency Analysis, in: Journal of Transport Economics and Policy, Vol. 43, No. 1, 2009, pp. 1-24.

16 M. Ivaldi, G. McCullough: Subadditivity Tests for Network Separation with an Application to U.S. Railroads, in: Review of Network Economics, Vol. 7, No. 1, 2008, pp. 159-171.

up to 24%, which confirms the qualitative results of Bitzan[17]. In a recent paper, Mizutani and Uranishi[18] utilise a sample of 23 OECD countries in the period 1994-2007 and conclude that train density is the determinant factor in establishing which organisational structure is more effective in reducing costs.[19] In comparison to these studies, which focus on the effects of separation on costs, Drew and Nash[20] present descriptive statistics suggesting that ownership integration may be advantageous in terms of transport performance and modal share. Our paper ties in with this study and aims to put its results to the test in a fully fledged econometric analysis.

The Empirical Model

In this section we present descriptive statistics, introduce the set-up of the empirical model, disclose sources of data and present the results of the panel regressions.

Modal Share as a Suitable Measure

Previous empirical studies shed light on important aspects of the question of which vertical structure fares best, especially in terms of efficiency. In comparison, our study focuses on the final outcome of the organisational models in terms of the modal share of rail ("the success of rail"), neglecting the underlying mechanisms. We take this share as a comprehensive measure for the attractiveness of rail.[21] In addition to lower prices made possible through cost reductions, an increase in punctuality or friendlier staff also impact positively on the attractiveness of rail. Thus the modal share accounts for all potential effects of a structural reform, even those that are difficult to observe and quantify.[22] In order to insulate the structural model's impact on this outcome, however, other potential drivers of the modal share have to be controlled for.

Another important argument for the use of the modal share is that both advocates and adversaries of full separation claim that their preferred models would increase the market share of rail. Therefore, it is only fair to assess the validity of the parties' reasoning by this measure. In a similar vein, the increase of the railways' share is an explicit goal of European as well as many national transport policies. Hence, one should expect that the success of rail plays a major role in political debates on the preferability of options for the railway structure.

Compared with other potential measures, the modal share is rather sticky, i.e. variations are relatively small, at least if one considers a limited time span of only a few years. One reason is that production processes and the habitual behaviour of commuters are not flexible enough to respond to small and/or transitory relative cost changes. To cope with the stickiness of the modal share, we use time lags for the effects of the organisational structure and the amount of public budget contributions.

Since an all-encompassing modal share would not be meaningful, our analysis must differentiate between passenger and freight transport. This requirement is not constrictive, however. Since competition evolves differently in these two segments of the transport market – e.g. due to differences in legislation, the role of governmental bodies and the competitive position of rail relative to other modes of transport – it is quite likely that the effects of the structural models differ, too.[23] Hence this differentiation is quite sensible.

Scope of the Analysis

Our regression analysis is based on data from nine countries: Austria (AT), Denmark (DK), France (FR), Germany (DE), Italy (IT), the Netherlands (NL), Sweden (SE), Switzerland (CH) and the United Kingdom (UK). These countries have been selected, firstly, because they are cited most frequently in the EU railway policy debate and cover the range of models at stake and, secondly, because data availability is relatively good thanks to past studies such as NERA[24]. Results qualify as valid arguments in the discussions on railway structure sketched above because European law applies.[25] No distortions from the breakdown of the Comecon are to be expected in the data. The largest European railway markets, France (highest volume of rail passenger transport) and Germany (highest volume of rail freight transport), are included.

17 J.D. Bitzan: Railroad Costs and Competition: The Implications of Introducing Competition to Railroad Networks, in: Journal of Transport Economics and Policy, Vol. 37, No. 2, 2003, pp. 202-225.
18 F. Mizutani, S. Uranishi: Does Vertical Separation Reduce Cost? An Empirical Analysis of the Rail Industry in OECD Countries, Working Paper No. 28, 2011, Graduate School of Business Administration, Kobe University.
19 See also T.H. Oum, W.G. Waters, C. Yu: A Survey of Productivity and Efficiency Measurement in Rail Transport, in: Journal of Transport Economics and Policy, Vol. 33, 1999, pp. 9-42 for a survey on former empirical studies.
20 J. Drew, C. Nash: Vertical Separation of Railway Infrastructure: Does it always Make Sense?, Working Paper No. 594, 2011, Institute of Transport Studies, University of Leeds.
21 See ibid., p. 2.
22 See ibid., p. 12.

23 See M. Ivaldi, G. McCullough, op. cit.
24 NERA: Public Budget Contributions to the Railways, 2005.
25 Even though Switzerland is not a member of the European Union, relevant Community law applies, following an agreement on land transport between the EU and Switzerland.

Table 1
Countries Considered and Their Classifications, 1994-2009

	Ownership separation	Holding model	Hybrid
Austria		1994-2009	
Denmark	2005-2009	1994-2004	
France		1994-1996	1997-2009
Germany		1994-2009	
Italy		1994-2009	
The Netherlands	1998-2009	1994-1997	
Sweden	1994-2009		
Switzerland		1994-2009	
United Kingdom	1994-2009		

The time span considered is from 1994 to 2009. During this period several of the countries implemented reforms of the railway sector and, as a result, changed categories. The Netherlands (from 1998 onwards), Denmark (from 2005 onwards), Sweden and the UK (both from 1994 onwards) are counted as "separated" railway systems (ownership separation, OS), while Austria, Germany, Italy and Switzerland have preserved a holding structure (holding model, HM). France constitutes a special case, since the infrastructure has been fully separated from the national rail carrier SNCF since 1997, but the owner of the infrastructure (RFF) has delegated several functions of the infrastructure manager back to the SNCF. For this reason, we use a third category "hybrid", to which we assign France.[26] The classification of the countries from 1994 to 2009 is depicted in Table 1.

Descriptive Statistics

Figures 2 and 3 show how the modal share of rail evolved for the passenger and freight segments in the OS and HM groups of countries.[27] As to the question of which organisational structure fares best, no quick answer is possible. In passenger transport, the modal share is higher on average in countries that have maintained the holding model, but the difference remains more or less stable. In freight transport, the modal split in the HM countries led to a higher growth rate on average than in countries with full ownership separation. This result could also be due to changes in the composition of the groups, however. For instance, the modal share of rail in the Netherlands was only 3.1% when

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26 See also European Commission: Accompanying Document..., op. cit. All conclusions drawn remain unchanged if France is counted as "separated" instead.

27 Note that the composition of the groups changed during the time span considered.

Figure 2
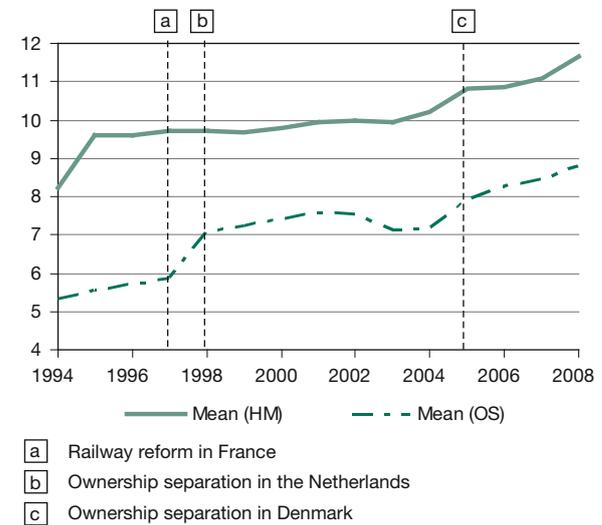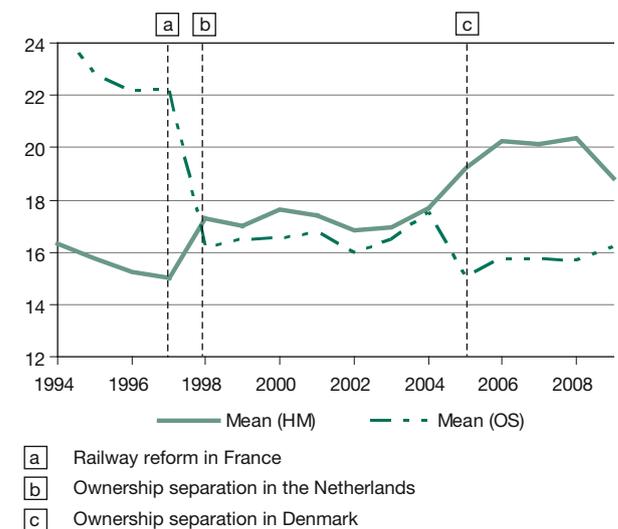**Modal Share of Rail in Passenger Transport**

a Railway reform in France
b Ownership separation in the Netherlands
c Ownership separation in Denmark

Figure 3
Modal Share of Rail in Freight Transport

a Railway reform in France
b Ownership separation in the Netherlands
c Ownership separation in Denmark

it became part of the OS countries in 1998. This had a considerable impact on the average modal share in this group, which was 22.3% in 1997. The changes in the composition of the groups in freight transport have a stronger impact than they do in passenger transport because differences between countries are more pronounced.

We conclude that the descriptive analysis is not capable of substantiating the call for a reform of EU legislation. Besides its ambiguity, the descriptive analysis also disregards the role of other factors in the success of rail, e.g. the degree of public financing. These factors are controlled for in the following panel data analysis.

Control Variables of the Econometric Analysis

Apart from the vertical structure of the railway sector, there are more parameters that impact directly or indirectly on the success of rail. They are accounted for by the introduction of control variables. One of them is the amount of public budget contributions for rail. Transport services are partially provided by order of public contracting authorities, particularly in local and regional rail passenger transport. Also, infrastructure investments are financed to a large extent by the public in all countries considered. One should expect that more public money enhances the market share of rail. This correlation is not unambiguous, though. Cost reductions by successful railways may make it easier for governments to cut budget contributions. Conversely, governments may support needy railway undertakings to overcome a crisis. Hence, it is by no means obvious that more public money is always correlated with a successful railway sector. Our regression model takes into account the mutual interference between public support and the success of rail, i.e. the "simultaneity" of both directions of causality. This is done using the share of the tertiary sector as an instrumental variable. Government support is included as euros (real, basis year 2001) per transport performance unit to reflect the different size of the countries. We use time lags to reflect that it often takes years until, for example, a publicly financed infrastructure enhancement leads to a change in demand.

A related control variable used in the regression analysis is the share of a government's total expenditures for transport purposes that is allocated to rail. We take this share as representative of the overall political propensity to support rail vis-à-vis other modes of transport. This attitude has beyond doubt a strong impact on the success of rail. It influences the institutional and legal environment of railway undertakings, as well as the fiscal setting and the promotion of other transport modes. Clearly, it is impossible to measure this attitude directly in a comprehensive way. In our view it is very unlikely, however, that a government would generously support rail financially – as compared to, for example, road or waterways – if it simultaneously hampers rail's development due to an unfavourable institutional or fiscal setting. Therefore, we see the share of rail in a government's transport budget as an imperfect yet best available proxy for the amicability of the institutional environment for rail in the considered countries.

Another control variable that we consider is the development of GDP per capita. Even though the modal share is less sensitive than other performance measures to economic expansions and downturns, an impact remains, e.g. because the unemployment risk differs between users and non-users of public transport, or because the production of categories of goods that are more or less rail-affine is affected differently by a crisis.

We also control for the impact of different degrees of market opening in the considered countries, making use of the IBM Rail Liberalisation Index.[28] This measure integrates a multitude of components affecting how open a market is from the point of view of a newcomer.

It is important to note that the Liberalisation Index refers to the absence of barriers to market entry – not to the actual market shares of competitors. Therefore, it also accounts for phenomena like potential competition or competition for markets (e.g. through competitive tendering) which play important roles in the railway markets.[29] Since the opening of markets evolved quite differently in the passenger and freight segments, we only use the values of the Liberalisation Index which differentiate between these segments for the years preceding its publication. Another control variable, the number of staff at the regulatory authority for railways, is meant to insulate effects from regulation of varying levels of intensity.

Methodology and Regression Equation

Our analysis is based on established panel estimation methods. The fixed effects (FE) model allows for correlation between regressors and individual effects, but coefficients of time-invariant variables cannot be identified. In comparison, the random effects (RE) model is able to identify the effects of time-invariant regressors, but may not be consistent. The Hausman-Taylor (HT) approach combines the advantages of the FE and the RE models, i.e. it is able to cope with variables that are time invariant, and also allows for correlation between regressors and individual effects. Finally, we derive the results for the pooled ordinary least squares (POLS) model. This model is only applicable if there is no heterogeneity at the country level, which is admittedly a very audacious assumption. Among the regression models employed, it therefore yields the least reliable results. Specification tests (Breusch-Pagan and Hausman) serve to decide which model is appropriate.

Among the variables employed, several show little or no variance. The classification of the countries changes at most once (e.g. France in 1998). Since the Liberalisation

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28 See IBM, C. Kirchner: Rail Liberalisation Index, 2007 and IBM, C. Kirchner: Rail Liberalisation Index, 2011.

29 By contrast, competition measures that are based on market shares, like e.g. the Herfindahl Index, fail to cope with such phenomena. In addition, market shares are inherently based on debatable definitions of markets. The "rail market opening score", published by the European Commission: Accompanying Document…, op. cit., p. 95, is ineligible in this respect, also because the values for four out of nine countries are not included.

Index only differentiates between passenger and freight transport from 2007 onwards, only two values are available for each country. Finally, the number of staff at the regulatory bodies is only available for one point in time. The stickiness of these variables means that the HT model may be appropriate.

The general regression equation reads[30]:

$$Mod = \alpha + \beta_1\, OS + \beta_2\, Hyb + \beta_3\, \Gamma + \varepsilon$$

Mod represents the modal share of rail, and *OS* is a dummy variable which has a value of 1 if the country has implemented ownership separation in the railways and 0 otherwise. Analogously, *Hyb* takes a value of 1 if the country is in the category "hybrid" (only France, see Table 1) and 0 otherwise. Γ is a control vector. It combines the values of all control variables for the country under consideration. ε is the residual, which is normally distributed and has a mean of 0.

Data Sources and Availability

All data stem from publicly accessible sources. Table 2 reports these sources in detail. Regarding the public budget contributions, our main source is NERA[31], which only covers the years until 2003, however. Therefore, we have completed these data with figures from annual reports and national statistics, employing the same methodology used by NERA. Public budget contributions are reported in Table 3.

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30 We omit time and country indices to enhance legibility.
31 NERA, op. cit.

Table 2
Data Sources

Variable [Dimension]	Source
Modal share of rail [per cent]	Eurostat (tables tsdtr210 and tsdtr220); Switzerland: http://www.bfs.admin.ch/bfs/portal/de/index/themen/11.html
Vertical structure [HM, OS, hybrid]	European Commission (2010), p. 18
Public budget contributions per performance unit PUBEX [euro/ptkm]	Budget contributions: NERA (2005); national statistics/annual reports; transport statistics: figures from Eurostat and national statistics sources[1]
GDP per capita GDPpc [euro/pop. size]	Eurostat (table nama_aux_gph)
Degree of liberalisation LIBEX [index points]	IBM and Kirchner (2007) and (2011)
Intensity of regulation [staff number]	IBM (2006)
Share of rail in total transport budgets SHARE [per cent]	Public budget contributions: see above; total transport budget: Eurostat (table cofog0405)

[1] Eurostat: Tables "rail_pa_total" and "rail_go_typeall", until 2004: http://www.eds-destatis.de/de/publications/select.php?th=7&k=2 (several instances), 2011; ORR: National Rail Trends 2010-2011 Yearbook, http://www.rail-reg.gov.uk/upload/pdf/nrt-yearbook-2010-11.pdf, 2011 (accessed 2/7/2012); Statistik Schweiz: EisenbahnZeitreihen, http://www.bfs.admin.ch/bfs/portal/de/index/themen/11/07/02/blank/03/02.html, 2011 (accessed 2/7/2012); Statistisches Bundesamt Deutschland: Statistik kurz gefasst, http://www.eds-destatis.de/de/publications/select.php?th=7&k=2, 2011 (accessed 2/7/2012).

Results

Table 4 summarises the results of the regression analysis in the passenger segment.[32] Most importantly, the panel data analysis provides strong evidence that ownership separation has a negative impact on the success of rail in passenger transport. This finding holds true in every regres-

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32 Values are based on heteroscedasticity- and autocorrelation-consistent standard errors.

Table 3
Public Budget Contributions to the Railways
in € million

Real, basis year 2001	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Austria	1,828	736	800	1,097	1,214	3,446	2,042	1,865	1,690	1,714	1,467	1,458	1,490	1,565	1,659
Denmark	296	325	386	446	633	674	750	727	920	900	848	857	834	830	889
France		5,389	8,564	7,507	9,943	7,910	6,940	8,829	7,783	9,423	9,551	9,794	9,297	9,864	10,033
Germany	12,950	11,802	11,163	9,980	10,598	9,913	9,978	9,637	9,128	6,468	8,078	8,023	8,066	8,062	8,123
Italy	4,605	6,308	4,603	7,184	6,840	7,597	6,949	8,942	5,818	5,291	5,527	3,743	4,444	4,386	4,675
The Netherlands	1,438	1,488	1,549	1,784	1,694	1,882	2,206	1,905	1,866	1,288	1,392	1,551	1,388	1,487	1,515
Sweden	1,458	1,329	1,035	1,142	951	752	819	1,015	1,249	1,165	1,182	1,181	1,260	2,491	1,239
Switzerland	1,572	1,846	2,014	1,609	1,798	1,888	2,638	1,428	1,432	1,320	1,318	1,269	1,264	1,520	1,248
United Kingdom	3,926	3,846	3,404	2,869	2,502	2,126	1,950	3,695	5,727	4,700	4,819	5,892	7,756	5,297	4,448

S o u r c e s : own calculation based on NERA: Public Budget Contributions to the Railways, 2005; various national statistics and annual reports.

Table 4
Results Passenger Transport

Variable	HT	FE	RE	POLS
Intercept	-0.5697		-0.2018	-1.7220
OS	0.7328***	-0.7142***	-0.7024***	-2.1417*
PUBEX	1.5564	5.8710	-1.9675	16.1984
GDPpc	0.0002***	0.0002***	0.0002***	0.0005
LIBEX	0.0069***	0.0078**	0.0074	-0.0070
SHARE	0.7602	1.0238	0.7322	-4.3921
Adj. R^2		0.5338	0.5938	0.4836
F-statistic	936.56	21.88	-8.80	13.01
	p<0.001	p<0.001	p=1	p<0.001
Breusch-Pagan (Chi²)				2399.22
Hausman (Chi²)			1.50	

*/**/*** significant at the 10/5/1 per cent levels, respectively.

Table 5
Results Freight Transport

Variable	HT	FE	RE	POLS
Intercept	4.2051		106.11**	142.27*
OS	0.3170	0.2228	-5.2825	-15.377**
PUBEX	-11.051	-61.987***	-812.23***	-1076.7***
GDPpc	0.0005***	0.0004	0.0001	-0.0004
LIBEX	0.0062	0.0053	-0.0339	-0.0376
SHARE	-8.878**	-10.177	-41.779	-80.642
Adj. R^2		0.2451	0.1410	0.2956
F-statistic	1058.8	1.17	-7.43	-8.23
	p<0.001	p=1	p=1	p=1
Breusch-Pagan (Chi²)				0.41
Hausman (Chi²)			2.75	

*/**/*** significant at the 10/5/1 per cent levels, respectively.

sion model.[33] All three regression models that are able to cope with heterogeneity at the country level (HT, FE, RE) display nearly the same value for the effect of ownership separation (-0.7 percentage points) with the highest level of significance. Only the POLS model displays a higher value (with a lower level of significance). The Breusch-Pagan test indicates that this model is not applicable (*p*<0.001), though. In comparison, the explanatory power (coefficient of determination, adjusted R^2) of the FE and RE models is fairly high (53-59%). The Hausman test indicates that the RE model is applicable (*p*=0.96).

Somewhat surprisingly, higher public expenditures for rail have no significant impact on the success of rail in our data (time lag of three periods). The same applies to the share of public expenditures for rail in the budgets for transport issues. In our interpretation, increased public outlays do indeed have a positive impact on the success of rail, but this effect is offset by the fact that less successful and more costly railway systems require and often receive greater public support.[34] By contrast, GDP per capita has an unambiguously positive impact on the modal share of rail (significant at the one per cent level). This result may be explained by fluctuations in the employment rate, which affects the share of commuters who use rail services. The effect of liberalisation is likewise positive and significant in the HT and FE models (at the one and five per cent levels, respectively). The latter result provides a compelling argument that the Liberalisation Index is indeed a meaningful measure. Obviously, the significance of this control variable could not be this high if it had been derived in an arbitrary way.

A 0.7 percentage point share loss for rail through ownership separation is a considerable impact. It corresponds with a shift of large volumes of traffic, which would increase congestion on the roads, CO_2 emissions, etc. Given the trade-off sketched above, two possible interpretations of this finding are that either separation does not have the expected positive impact on competition or the induced increase in competition does not translate into benefits for rail users. The positive effect of liberalisation seems to indicate that competition does indeed have a positive effect, which supports the former interpretation.

Table 5 summarises the results of the regression analysis for the freight segment.[35] In freight transport, no reliable result for the effect of ownership separation can be derived. Two models predict a positive effect from full separation (insignificant), and two models predict a negative effect (one is insignificant and the other is significant at the five per cent level). Four periods were used for time lags. The Breusch-Pagan test indicates that POLS is not suitable (*p*=0.52). The Hausman test suggests that RE may be used (*p*=0.84), but the explanatory power of that model is very low (R^2=0.14).[36]

Why is it not possible to derive results that are as comparably reliable as in the passenger segment? One hypothesis is that on-track competition plays a stronger role in the freight segment, so that the advantages of ownership integration are partially offset. The low coefficients of determination tend to suggest, however, that factors that

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33 If France is counted as "separated", the qualitative results remain stable.

34 See e.g. I. Murray: No Way to Run a Railway: Lessons from British Rail Privatization, Technical Report, Adam Smith Institute, London 2005.

35 Values are based on heteroscedasticity- and autocorrelation-consistent standard errors.

36 If France is counted as "separated", all four regression models indicate an advantage of the holding model. Coefficients of determination and levels of significance are comparably low, however.

are neglected in our model are at work. For instance, the share of trains that cross borders is much higher than in the passenger segment, often accounting for more than half of the transport volume. Obviously, the high share of international trains complicates an analysis of success factors at the national level. Besides, differences in the technical provisions, e.g. regarding the command and control technology, current supply, etc., possibly have a strong impact on the success of rail vis-à-vis other modes of transport. The inclusion of variables controlling for these and other factors could possibly lead to more robust results in the freight segment as well. With our data and regression models, the only conclusion that may be drawn regarding the freight segment is that there is no evidence of advantages that ownership separation would bring about.

Conclusions

Our analysis is motivated by ongoing initiatives to establish complete separation between rail infrastructure operations and transport activities as the only permissible option at the European Union level. The underlying hypothesis behind these initiatives is that separation reinforces intramodal competition and that on-track competition would be a major spur to the competitiveness of rail.

We test this hypothesis using data for nine European countries in the period 1994-2009. Descriptive statistics by Drew and Nash[37] already suggest that separation does not actually bring about the advantages expected by its advocates. Our econometric analysis confirms and amplifies these findings in the passenger segment, using the modal share of rail as the dependent variable and controlling for factors such as public support for rail, the degree of liberalisation and GDP per capita. Our main result is that ownership separation tends to weaken rail considerably instead of strengthening it. A parallel approach in the freight segment does not yield robust results. Here, further research would be required to identify the key drivers behind the success of rail.

Against the background of our analysis and the cited evidence, the European Commission's announcement to tighten the existing unbundling provisions is premature, to say the least. Full ownership separation may even contradict the declared goal of the European Union and of several national governments to increase the market share of rail. If the member states' current freedom to choose the organisational structure that they consider appropriate is to be eliminated by Community law, this should be based on clear evidence in support of the remaining options. By contrast, our findings support the European Commission's announced initiative to liberalise the rail passenger market.

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37 J. Drew, C. Nash, op. cit.