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Railway Alliances in EC Long-Distance Passenger Transport: A Competitive Assessment Post-Liberalization 2010

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Contents

Tables

Figures

Abstract

In 2010 the legal barriers for international, intramodal competition in long-haul passenger transport in the railway sector will be abolished. This report analyzes the extent to which effective competition will arise in long-haul passenger transport after liberalization—from 2010 onward—and how co-operative agreements between European rail operators may impact the liberalization process. The study also provides an overview of the existing literature related to entry and intramodal competition in the rail sector, as well as intermodal competition between aviation and rail. In addition, it provides a review of the legal and regulatory environment of the sector at a European level and evaluates current organizations operating in it.

The main conclusions are the following:

- We find robust evidence for effective competition between low cost airlines (LCAs) and rail operators. A rail operator loses at least 7% of its passengers and 8% of its passenger kilometers due to entry by LCAs. We also find evidence of negative price effects of strategic LCA entry in both first class and second class. This demonstrates that LCAs are a significant competitive constraint for rail operators.
- Based on a revenue & cost model ("R&C model"), only a minority of long distance origins and destinations (O&Ds) are profitable with respect to both operating profitability and total profitability from a pre-entry perspective—that is before entry by competing rail operators. This result does not change drastically even under optimistic but reasonable assumptions regarding future changes in demand, costs, and degree of intermodal competition.
- An analysis of various entry strategies identifies the most profitable strategy as entry by an independent entrant with inferior technology. However, such a strategy is specifically vulnerable to legal and strategic limitations on exploitation of network effects (e.g. by imposing national levies or incompatibilities in ticketing or train schedules).

- Overall, we find very limited evidence for intramodal competition arising on international O&Ds for long distance passenger travel after 2010, while past experience from airline alliances—although in a different competitive setting—promises significant efficiency gains as a result of international alliances.

Management summary

The European Parliament and the EU Council ratified the Third Railway Package in October 2007. Its main objective is to open up international passenger rail traffic for competition. The package was only ratified in the third reading, though, after the integration of major modifications, including the delay of the opening of international passenger transport until January 1, 2010, instead of 2008. Furthermore, the Council introduced a strict definition of "international traffic" ("principal purpose" of the service must be the carriage of passengers between stations located in different Member States), and an additional safeguard for public service transport: the member states' right to charge a levy on international rail passenger services in order to contribute to the financing of public service transport. Given the specificities of long distance passenger transport, it is, however, unclear whether the envisaged market opening will result in effective intra-modal competition.

Various European train companies, including the German rail operator Deutsche Bahn ("DB"), have initiated a cooperation to provide seamless services for long distance passenger transport on the high-speed train infrastructure ("Railteam"). Beyond the assessment of the Railteam alliance, the more general question arises of how far co-operations between incumbent rail companies may impede effective competition in the long-distance passenger transport segment following liberalization or—to the opposite—are even needed for effective competition to emerge.

In analyzing this question, two additional questions seem central for overall assessment in the field of long-haul passenger transport:

a) the dimension and size of intermodal competition from aviation;

b) the intensity of intramodal competition probably occurring without any co-operation after liberalization (i.e. the likely intramodal counterfactual situation).

This report has been commissioned by Deutsche Bahn, one of the major European rail service providers and an internationally operating logistics company, which already is—or in the near future may well be—directly affected by the degree of intermodal and intramodal competition in European long-distance passenger transportation. Based on an extensive dataset provided by DB, the report uses Germany (with extensions into its West European neighbouring countries) as an example with the objective of finding answers to the above-mentioned questions. It carries out an empirical analysis along two lines: First, a panel data analysis is conducted in order to evaluate the impact of intermodal competition on relevant rail routes ("panel data analysis"). In particular, we analyze the impact of entry by low cost airlines on a specific O&D on DB's prices, output, and revenue figures. Second, we assess the likelihood of entry on individual O&Ds in various entry scenarios, based on a set of indicators including the level of intermodal competition as measured earlier ("scenario analysis"). This allows us to identify future counterfactual situations under the assumption of implementation of the Third Railway Package and to analyze the impact of alliances from a competition policy perspective.

Literature review

A view on the general literature on entry barriers suggests that entry in the passenger rail transport industry is likely to be constrained by multiple obstacles: the literature on intramodal competition indicates that economies of scale and density as well as network effects discourage entry. The empirical literature on intermodal competition indicates that rail and aviation have increasingly converged into one market. This is the case both from the perspective of customers as well as for train and plane operators, who consider each other as competitors. With respect to alliances recent literature on airline alliances indicates that the majority has welfare-enhancing effects. The major effects of the alliances, in particular the removal of the double-marginalization externality, efficiency gains, and the expansion of networks and flight frequencies, are manifest with alliances in other sectors as well.

The regulatory environment

The Third Railway Package has the objective to induce and foster competition in rail passenger transport. However, its implementation has been delayed, and several regulatory elements that have been added—like a public service operator levy—suggest that the rail sector will remain an industry under close scrutiny and protective measures from some national governments. Pro-competitive agencies like the German Monopolkommission view competition in the sector as an achievable objective but clearly state that entry faces major hurdles. With respect to intermodal competition, the European Commission claims that the substitutability of different transport modes depends especially on the needs of a particular group of travelers and that traveling time rather than distance is the decisive factor for consumers when it comes to the substitutability of alternative means of transport. However, competition authorities acknowledge that the distance range in which aviation and railways directly compete may be limited. For example, the Monopolkommission has a rather restrictive view of the competitive impact of aviation on trains outside the 400 km to 600 km range.

Existing and past co-operations

Co-operations in the European passenger rail system have existed since the 1950s, when the Trans-Europe Express network was established, and have since then continued with the EuroCity system and a range of bilateral and trilateral co-operations that mainly target marketing and interoperability. Railteam, an alliance between incumbent rail operators, therefore stands in a long tradition of providing integrated European rail services to passengers. It bundles the activities of incumbent rail operators in the "software" component of transport services, thus enhancing passenger comfort and service quality without interfering in operators' independent determination of the existence, extent, and frequency of individual train services. The "software" focus of Railteam coincides with the commission's quest for further standardization of services across Europe subject to investigation and is thus unlikely to inflict serious concerns under the EC's guidelines on Article 81 applicability to horizontal agreements.

Quantitative analysis: Data set

The assessment is based on a unique and comprehensive data set of 207 national and international O&Ds (starting or ending in Germany). The data set covers monthly price and passenger data over the period January 2006 to October 2007. This data, disaggregated for first and second class, has been provided by Deutsche Bahn (DB). It has been supplemented by variables based on publicly available and specifically collected data describing railway costs and quality, LCA entry and presence, and demand shifters for transportation by airline and car.

Methodology

The empirical analysis carried out here has two dimensions. First, a panel data analysis is conducted in order to evaluate the impact of intermodal competition on relevant rail routes ("panel data analysis"). In particular we analyze the impact of entry by LCAs on a specific O&D on passenger numbers, prices, revenues, and passenger kilometers of the rail operator. Second, the likelihood of entry on individual O&Ds is assessed for various entry scenarios based on a pre-entry profitability analysis of individual O&Ds ("scenario analysis"). This allows us to identify a future counterfactual after-liberalization situation and to analyze the impact of alliances within such an environment.

Main results: Panel data analysis

We find robust evidence for effective competition between LCAs and rail operators affecting first and second class passenger numbers, price revenues, and passenger kilometers to various degrees.

Passenger numbers

LCA entry has a negative long-term effect on passenger numbers. In our complete sample of 207 O&Ds, second class passenger numbers fall by 7% upon LCA entry. In a more limited sample comprising 84 O&Ds covering large domestic routes on which DB offers high quality service and where airlines are already operating multiple services at the beginning of our sample period, LCA entry is associated with an even larger 17% reduction in second class and an 18% reduction in first class passenger numbers; these reductions are robust for a large number of controls.

The negative impact of LCAs on second class passenger numbers is likely to reflect the fact that these rail customers are (quality-adjusted) price sensitive and are therefore attracted by LCAs. The negative effect associated with first class passenger numbers may reflect the fact that although LCAs tend not to be the transport mode of choice for business clientele, national carriers (such as Lufthansa) often react to LCA entry by lowering their prices. And the national carriers are likely to be attractive to first class rail passengers.

Prices

Our finding is that, controlling for the possibility that LCA entry on a given O&D at a given point is not a random decision but rather a strategic one, LCA entry is likely to put significant downward pressure on rail ticket prices in both first and second class.

Revenues

We find that LCA entry is associated with no significant long-term change in second class revenues for the complete sample. However, the large negative passenger effects in our limited sample, which comprises 84 O&Ds covering large domestic routes on which the incumbent rail operator already offers high quality services and where airlines are already operating multiple services at the beginning of our sample period, is reflected in a corresponding 16.7% reduction in second class revenues and a 15.7% reduction in first class revenues for these O&Ds. This result is robust for a large number of controls and suggests that even in the absence of any price effect, the loss of passengers that has accompanied competition from LCAs (either directly or as a result of competitive reactions from national carriers) is likely to culminate in large reductions in revenues in both first and second class on many major O&Ds.

Passenger kilometers

LCA entry and operation is associated with an 8.9% decline in second class passenger kilometers and no corresponding change in first class passenger kilometers for the complete sample. In the limited sample of 84 O&Ds for which the result is robust for a large number of controls, it is associated with a 16.4% reduction in second class and a 23.1% reduction in first class passenger kilometers. The fact that we observe a fall in second class passenger kilometers in the complete sample reflects the high likelihood that a rail operator faces the largest competitive pressure on distant O&Ds in particular.

Main results: Scenario analysis

Our scenario analysis is based on a revenue and cost model for individual O&Ds ("R&C model"). The R&C model gives an indication of pre-entry profitability on an individual O&D level with respect to both operating profitability and total profitability. The R&C model is calculated based on assumptions regarding current and future cost and revenue figures ("status quo scenario" and "base scenario 2010," respectively).

Pre-entry profitability: Status quo scenario

Based on the R&C model we find an overall low level of profitability with respect to total profit. Of the 207 O&Ds in total, only four break even, and none of these is an international route. With respect to operating profits, we find 18 O&Ds to be profitable. International O&Ds have a share of slightly less than a third, with five observations. International routes are therefore underrepresented in the group of profitable O&Ds (representation in the overall sample is 62%). For those international routes that are profitable most of the revenue is driven by domestic intermediate passengers. This low level of profitability of most of the routes may explain why in Germany, where entry in long-distance rail passenger transport is already possible, very few routes have actually experienced new entry.

Pre-entry profitability: Base scenario 2010

The base scenario 2010 relies on optimistic but reasonable assumptions about future cost and revenue figures. These assumptions sketch a vision of the future with minor but not unimportant technological developments, a realistic rise in passenger numbers, and realizable increases in overall business efficiency. In detail, the assumptions project the following developments:

- an increase in total passenger numbers by 5% on all routes by 2010;
- an additional 10% increase in passenger numbers on routes on which LCA entry occurred over the observation period. This reflects the assumption that due to high kerosene costs, low-cost airlines are likely to stop service on some routes and that primarily routes will be affected, which have recently been established;
- a reduction in variable costs (costs for drivers and other on-train staff) by 10%;
- a reduction in fixed costs: rolling stock maintenance by 10%, administration, overhead, and ticket sales by 20%.

Compared to the status quo scenario, only one additional O&D becomes profitable with respect to total profitability and no further O&Ds become profitable with respect to operating profitability.

Entry analysis 2010

The pre-entry profitability analysis already suggests that even under more favorable conditions than in 2007, entry remains rather unlikely on the vast majority of O&Ds. Using the base scenario 2010 as the starting point, the profitability of various entry strategies can be analyzed further. What follows is an overview of post-liberalization entry strategies considered plausible, with a summary of our main results regarding their profitability.

Incumbent expansion/top-down/with cabotage (high speed rail, "HSR", from neighboring territory)

This scenario can be interpreted as a confirmation of the base scenario 2010, where incumbents entering from neighboring countries would have to reject any expansion into German territory on profitability grounds. The cash-generating routes in the German network are identified as located within German territory, which makes cross-border expansion less likely.

Incumbent expansion/top-down/without cabotage

O&D specific profitability is significantly lower compared to the scenario with cabotage. An incumbent expansion strategy thus seems even less likely in such a scenario, underscoring the importance of network effects and the risks associated with any legal or strategic limitations imposed on an entrant's potential to attract intermediate or transfer passengers.

Independent entrant/top-down (independent HSR)

While profitability estimates shift up-ward, total profitability remains negative for the bulk of the examined O&Ds, only a few routes moving into the profit zone, all of them within Germany (although with extensions in neighboring countries).

Independent entrant/bottom-up (independent IC operator)

The total profit figures show that 16 O&Ds lie beyond the break-even point, including longer, international routes. Overall, most of the O&Ds are close to the break-even point, indicating a relatively high entry probability. Variations of this scenario show that if cabotage is forbidden on the intercity level, all routes are below profitability levels with respect to total profits and only few routes would break even in operational profits. By contrast, if joint ticketing and "hop-on-the-next-train" regulations were imposed by European authorities or national regulators on intercity services and any O&D could be complemented by existing transfer passengers on complementary IC routes, the number of O&Ds with a positive total profit would be increased from 16 to 19 on domestic territory and to 20 if international transfer passengers were included. The amount of routes with positive operating profit would rise from 59 to at least 61 domestically, even with a public service levy, and to at least 64 operationally profitable O&Ds with international transfer passengers.

Overall assessment and the impact of alliances

A review of existing alliances reveals that in the passenger railway sector, when it comes to long-distance transport, no alliances currently exist that have the depth and reach to drastically change the competitive position vis-à-vis air transport on international routes. While any such co-operation would have to be carefully examined from a competition policy perspective, this report adds some important elements to such an assessment.

First, we find that in a counterfactual situation without alliances the likelihood of strong intramodal competition emerging is low. Most importantly, high capital costs prevent entry within the high-speed segment of the market, in particular in the case of international O&Ds, where based on future revenue figures and plausible cost assumptions profitability cannot be expected. A high risk exposure due to uncertainty on regulatory conditions and fluctuations in passenger numbers most probably further aggravate the conditions for new entrants trying to offer services on European rail infrastructure. Within such a counterfactual situation, alliances that are limited to O&Ds with a low likelihood of intramodal entry will most likely have no anti-competitive effects.

Second, our scenario results suggest that effective and profitable entry in larger numbers is likely to occur—if at all—only in the intercity, i.e. low-speed segment of long-distance passenger transport. This type of entry is most likely to occur on O&Ds with a sufficient number of interim stops and a regulative environment allowing transfer passengers to change operators to some degree. Asymmetric liberalization may result in strong country disparities with respect to such competition, because independent operators rely strongly on integration into existing long distance and regional networks, and are more vulnerable to a public procurement levy. In so far as alliances between incumbent operators aim at excluding such forms of competition by low speed/ independent operators, our analysis suggests a need for significant efficiency gains to counterbalance the potential negative effects.

Third, our analysis indicates a need to more broadly integrate competition by other modes of transportation into a competitive assessment of alliances. The negative effects of LCA entry on rail passenger numbers are significant from both a statistical and economic perspective: competition by air transportation puts a significant restraint on rail operators. Most interestingly, our results indicate that at least on domestic routes, where rail operators have more leeway to adjust prices, intermodal competition does affect average rail prices despite the overall price rigidity of an open network structure.

With respect to economic benefits, current efforts of incumbent rail operators to offer joint ticketing and “hop-on-the-next-train” options to some extent mirror efforts by the European Commission (EC) to create a joint and transparent market and suggest a fair share being set aside for customers associated with such alliances. Deeper alliances may allow further efficiencies related to pricing, eliminating double marginalization and introducing higher pricing flexibility on international routes. The case of airline alliances, as outlined in the literature overview, could hint that co-operation may lead to lower prices and better customer service. Whether or nor this is the case for railways remains untested.

1. Objective of the study

The European Parliament and the EU Council ratified the Third Railway Package in October 2007. Its main objective is to open up international passenger rail traffic for competition. The package was only ratified in the third reading, though, after the integration of major modifications, including the delay of the opening of international passenger transport until January 1, 2010, instead of 2008. Furthermore, the Council introduced a strict definition of “international traffic” (“principal purpose" of the service must be the carriage of passengers between stations located in different Member States), and an additional safeguard for public service transport: the member states’ right to charge a levy on international rail passenger services in order to contribute to the financing of public service transport. Given the specificities of long distance passenger transport, it is, however, unclear whether the envisaged market opening will result in effective intramodal competition.

Several European train companies have joined a cooperation to provide seamless services for long distance passenger transport on the high-speed train infrastructure (“Railteam”). Given its limited scope and the low level of liberalization of the relevant long-distance passenger transport segment in Europe, the Railteam cooperation has to be considered unambiguously pro-competitive at the moment. The more general question arises, however, of how far co-operations between incumbent rail companies support (or are even needed for) effective competition in the long-distance passenger transport segment following liberalization.

In analyzing this question, two additional questions seem central for the overall assessment in the field of long-haul passenger transport:

a) the dimension and size of intermodal competition from aviation;

b) the intensity of intramodal competition probably occurring without any co-operation after liberalization (i.e. the likely intramodal counterfactual situation).

This report aims at providing an answer to both questions by carrying out an empirical analysis along two lines. First, a panel data analysis is conducted in order to evaluate the impact of intermodal competition on relevant rail routes ("panel data analysis"). In particular, we analyze the impact of entry by low cost airlines on a specific O&D on DB's prices, output, and revenue figures. Second, we assess the likelihood of entry on individual O&Ds in various entry scenarios, based on a set of indicators including the level of intermodal competition as measured earlier ("scenario analysis"). This allows us to identify future counterfactual situations under the assumption of implementation of the Third Railway Package and to analyze the impact of alliances from a competition policy perspective.

In the following two sections, an overview of the literature and of the regulatory environment will be provided. In section four, the legal framework under Article 81 and major elements of the co-operative Railteam agreement will then be summarized. Section five—the main part of the report—provides an analysis of competition for long-distance passenger transport. Here we describe the methodology applied, the underlying data set, and the results of the two lines of empirical analysis—panel data analysis and scenario analysis. Section six ends with a final assessment of alliances in the framework of the counterfactual world that has been derived.

2.
Literature review: Intra and intermodal competition

The question at hand is tied to various strands of literature. In the first part of the literature review, we will explore how entry is described within the perspective of the industrial organization literature. Thereafter, major studies of the more specific literature on intramodal and intermodal competition in the railway sector will be presented. In a final step, an overview of the theoretical and empirical literature on airline alliances provides some insights into the effects of alliances on cost savings and network efficiencies.

2.1 Theoretical approaches to entry

The structural characteristics of railways in continental Europe as a public good and infrastructure service imply that—as long as the sector is not radically transformed by divestiture and horizontal separation, as in the "tabula rasa" approach chosen by the British authorities in the 1990s—any competition follows from successive entry of new competitors in a market dominated by an incumbent rail company. This literature review therefore focuses on the possibilities of new entry in a contestable market.

In general, we can distinguish between static and dynamic models of entry. Bain's (1949) seminal paper on limit pricing is the first study to establish a formal model of potential entry (or entry deterrence) in an oligopoly setting. According to Bain, sellers may refrain from maximizing the industry profit in order to prevent new entry to the industry. Hence, prices lower than expected by Cournot competition may be present as a strategic tool of the incumbent. More specifically, Bain (1956) distinguishes three different conditions that are particularly likely to create barriers to entry:

i. Product differentiation

ii. Absolute cost advantages

iii. Economies of large-scale operations

According to Bain (1968, p. 252), the height of entry barriers can be measured by "the extent to which, in the long run, established firms can elevate their selling prices above the minimal average cost of production and distribution without inducing potential entrants to enter the industry." Bain's definition of barriers to entry is based on his structure-conduct-performance paradigm and has been criticized in at least two respects: if a company's product enjoys a superior status to other firms' products despite lacking any absolute cost advantages, or if there is not enough demand for an incumbent to cover its costs,[1] barriers to entry exist that are not covered by Bain's definition.

In contrast to Bain's approach, Stigler (1968) suggests a purely cost-based definition of barriers to entry. He argues that they are costs that have to be borne by entrants but are not borne by incumbents. Scale economies are not necessarily barriers to entry, as long as entrants have equal access to technology. Although Stigler's assumptions may be correct in a theoretical setting, the notion of sunk costs may create a decisional asymmetry deterring competitors from entering the market. In addition, the incumbent's brand recognition that entrants face may reduce the possibility of successful entry into a new market.

An application of the definitions of barriers to entry to the railways sector reveals that a number of conditions are fulfilled that make entries more difficult than in other industries. The following table lists the major arguments and their applicability to railways:

[1] For a thorough discussion of the different approaches to barriers to entry, see OECD (2005), p. 20-25.

Table 1: Barriers to entry: Review of the relevant literature[2]

Reason for a barrier to entry	Description	Main references	Applicability to railways	Possible indicators
Product differentiation	Incumbents can pre-empt the market through brand proliferation, i.e. existing firms can choose to produce different varieties of the same product in a way removing necessary space so as to avoid the entrance of newcomers; or consumers prefer the incumbent's version of the product.	Bain (1956), Schmalensee (1978), Di Cola (2006)	Yes	First class/ second Class differentiation; special offers, rebate and customer loyalty schemes.
Absolute cost advantages	Absolute cost advantages imply that the entrant will enter with higher unit costs at every rate of output, perhaps because of inferior technology.	Bain (1956), Vickers and Yarrow (1988)	Yes - incumbents can rely on expertise and efficiency in the management of their operations.	Average cost estimates (available only on a national level, not O&Ds).
			No - in contrast to profit-maximizing entrants, incumbents (especially regulated companies with public enterprise character) might suffer from inefficiencies due to a different objective function than profit-maximization (employment, universal service, etc.).	Average cost estimates (available only on a national level, not O&Ds).

2 For further information, please see also Di Cola (2006), http://www.ictregulation toolkit.org/en/Section.1712.html.

Reason for a barrier to entry	Description	Main references	Applicability to railways	Possible indicators
Economies of scale	A new facilities-based entrant may have no choice but to start out at a relatively large scale of operations in order to achieve unit costs close to the incumbent's.	Bain (1956)	Yes - average service costs (cost per passenger kilometer) decline with the number of units produced (in batch size). Such economies can be affected by using larger trains and increasing the load factor. Large fixed costs and small variable costs give rise to a minimum viable scale, which has to be exceeded in order for the firm to earn a profit in the market.	Load factors of trains (number of passengers carried vs. total capacity); absolute number of passengers.
			No - because limited operations on a single O&D ("cherry-picking" or "cream-skimming") are feasible without the creation of a network.	Entry on individual O&Ds (Arriva, Vogtlandbahn).
Network effect 1: Mohring externality	A good or service has a value that increases with the number of existing customers; as the demand for travel increases, a higher frequency of services can be supported, and the individual user also incurs a smaller average generalized cost as a higher quality of transportation due to time-savings.	Mohring (1972)	Yes	Train frequency.

Reason for a barrier to entry	Description	Main references	Applicability to railways	Possible indicators
Network effect 2: Negative opportunity costs of transfer passengers	An incumbent system operator can offer a service that reduces the costs of switching between different services; the ability to manage flow traffic and compete over alternative routings is enhanced; dominant hubs in route networks.	Seabright (2003)	Yes - the negative opportunity costs of the incumbent will be larger the more polycentric the network and resulting effects are.	Number of major stops on the route; number of hubs on the route; proportion of population in stops on the route to population in O&D.
Investment and sunk costs	If an entrant must incur high sunk costs to enter the market, then the entrant must be prepared to absorb those sunk costs in the event that it fails. However, at the time the new carrier is weighing its prospects and incurring sunk costs, the incumbent carrier faces none of the same risks or costs (even if it did so at an earlier point in time). This basic asymmetry in positions may pose an entry barrier for the prospective new carrier.	Stigler (1968)	Yes - the purchase price of a new high-speed passenger train is well above €15 million (e.g. the new AGV trains ordered by Nuovo Trasporto Viaggiatori cost €26 Mio. each), the operability requirements on national or multinational level have a long duration and are sunk.	Total revenues on individual O&D
Essential facilities	If an entrant needs access to an essential facility that is controlled by one of its competitors, this creates a barrier to entry. The entrant must incur the cost of purchasing access to the facility, a cost not faced by the firm that owns the essential facility. Necessary conditions for an essential facility include: (a) the facility must be controlled by a dominant firm; (b) competing firms must lack a realistic ability to reproduce the facility; (c) access to the facility is necessary in order to compete in the related market; and (d) it must be feasible to provide access to the facility.	Sullivan and Hovenkamp (2004)	No - railway tracks and infrastructure have been opened up for competition under the EU regime.	(Track costs per kilometer)

Reason for a barrier to entry	Description	Main references	Applicability to railways	Possible indicators
Government regulation	Regulation may establish a statutory monopoly or make competition outright illegal - one reason may be the desire to prevent welfare-decreasing excessive entry.	Mankiw and Whinston (1986)	No - natural monopoly for the tracks and infrastructure, but operation of trains can be organized competitively.	(Regulatory review)
	Special requirements for licenses or permits may raise the investment needed to enter a market - especially due to safety obligations.		Yes	Estimate of costs for permits and licenses.
Predatory pricing	The incumbent sells its product or service at a loss to make entry less likely; in particular, incumbents with large lines of credit, soft budget constraints, or free cash reserves can engage in those practices.	McGee (1958), Demsetz (1982)	No - railways are facing competition from cars and planes; if observable, lower prices (see Trenitalia) may also be induced by government regulation as a public service or because of environmental reasons (trains are energy-saving and affect the climate less than other means of transport).	Price ratio per kilometer comparison with other means of transport.
Advertising	A marketing advantage of consumers being more familiar with an existing brand than a new brand of a product enables the existing firms to formulate advertising campaigns that reduce the effectiveness of potential entrants' advertising in stimulating sales.	Bain (1956), Porter (1976), Netter (1983)	Yes	Marketing spending per passenger kilometer; special advertising campaigns for specific O&Ds.

Reason for a barrier to entry	Description	Main references	Applicability to railways	Possible indicators
	The entrant perceives a greater likelihood of success in markets where advertising is important.	Kessides (1986)	Yes	Marketing spending per passenger kilometer; special advertising campaigns for specific O&Ds.
Research and development / Patents	The impact of R&D (or patents) depends on the phase of the industry evolution.	Mueller and Tilton (1969)	No - technologies available in the market; mature industry.	(Upstream seller concentration, degree of vertical integration between train operators and manufacturers).
Artificial compatibility / customer loyalty	The incumbent may be able to create demand-side entry barriers by creating what may be called "artificial compatibility" between otherwise unrelated goods or services: even if there are no differences in costs between the incumbent and a potential entrant, there will be an incentive to offer in-kind inducements to agents.	Cairns and Galbraith (1990), von Weizsäcker (1981)	Yes - customer loyalty schemes exist with DB.	Ratio of BahnCard users (up to BahnCard 100) to full-tariff customers on specific O&Ds, especially services with a high frequent commuter ratio like Berlin – Hamburg.
Inelastic demand	An entrant's strategy of selling at a lower price in order to penetrate markets is ineffective with price-insensitive travelers.	Caves (1964) based on Modigliani (1958), Johnson and Helmberger (1967)	Yes - relevant for first class DB passengers.	Demand elasticity estimates for specific O&Ds, in particular for first class DB passengers.
Strategic alliances	Discriminatory access to through fares for code-share partners, unilateral trunk codeshares, discriminatory proration provisions, block-space agreements (as in the airline industry).	Wiener (2007), Varadarajan and Cunningham (1995), Hynes and Mollenkopf (1998)	Yes	Specific alliance agreements.

Sources: Sources indicated above.

As column 3 in table 1 indicates, twelve out of fourteen underlying reasons for the potential existence of barriers to entry can—at least partially—be linked to passenger rail transportation. A view on the general literature of barriers to entry hence suggests that entry in the industry that is the topic of this report is likely to be constrained by multiple obstacles.

2.2
Intramodal competition

The liberalization of the railway sector in Europe has fostered the emergence of a range of studies and papers dealing with the direct and indirect effects of competition (IBM 2007, Andersson 2005, Holvad, Preston, and Huang 2003, Nash and Rivera-Trujillo 2004, Preston and Dargay 2005, Friebel, Ivaldi, and Vibes 2003), measurement of efficiencies (Ivaldi and Vibes 2003, Urdánoz and Vibes 2006, Growitsch and Wetzel 2006, Friederiszick, Röller, and Schultz 2003), regulatory and institutional change (Di Pietrantonio and Pelkmans 2004, Debrie and Gouvernal 2006, Karsten 2007), air-rail intermodality (RAIFF 2006), and technological progress (Campos, De Rus, and Barron 2006, De Rus and Nash 2006). In this section, we emphasize two important aspects of the literature on competition in passenger rail transport, intramodal and intermodal competition.[3] This focus corresponds to the objective of our subsequent analysis. In addition, an overview of the empirical literature on airline alliances provides some insights into the benefits of alliances with respect to cost savings and network efficiencies.

A major theoretical treatment of intramodal competition in the railway sector is proposed by Villemeur, Ivaldi, and Pouyet (2003). The authors examine the topic of entry in the rail industry in a setting that allows for price differentiation and varying efficiencies of the incumbent and the competitor. In a base case of a monopoly, the incumbent train operator has an incentive to restrict demand in order to impose a higher price. Following a rationale of excluding passengers with lower valuations for train services from the market, only the most profitable passengers (i.e., those with the highest willingness to pay) are kept. If those passengers are sufficiently sensitive to travel time reduction, an efficient monopolist incumbent implements the lowest travel time consistent with the network, i.e. concentrates on its high-speed connections.

The authors suggest varying cases and entry scenarios, depending on the efficiency gap between the entrant and the incumbent. First, if the incumbent is as efficient as the entrant, then a service targeted toward the most profitable segments can be assumed to also be the most profitable option for the incumbent. A similar strategy is preferable if the incumbent anticipates that the entrant will not differentiate its product. By contrary, if the incumbent is much less efficient than the entrant, an incumbent is better off targeting its offer

[3] While air-rail intermodality depicts the optimization of travel services in a complementary combination of air and rail services, intermodal competition deals with the aspect of substitutability of the two means of transportation.

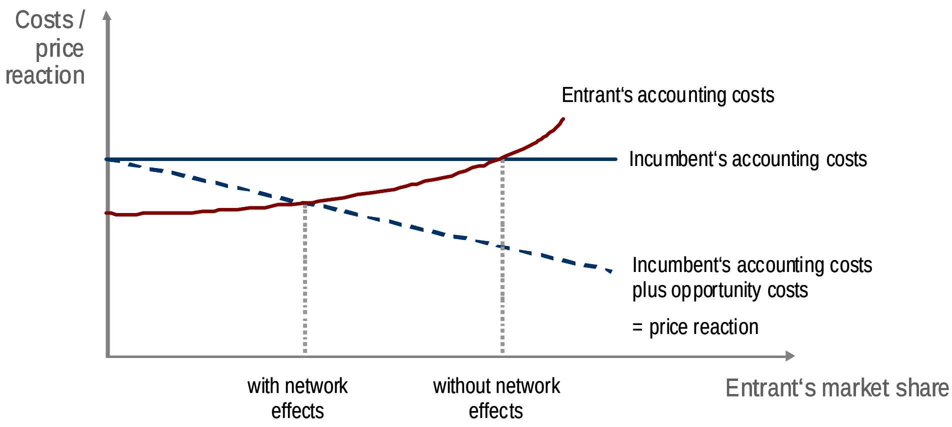
towards a niche market (less profitable segments and lower willingness-to-pay passengers) and retreat from the profitable high-speed segment of the market.

In general, Villemeur, Ivaldi, and Pouyet (2003, p.5) claim that in some situations, especially if entry costs are non-negligible or if the incumbent benefits from large returns to scale and/or returns to density, entry and competition may have a negative effect on total social welfare, because the erosion of the incumbent's market share induces a lower efficiency of the incumbent operator post-entry.

Seabright (2003) assembles a theoretical and empirical survey on the management and regulation of passenger rail transport. He presents empirical findings on supply, demand, and performance of passenger rail services and discusses price elasticities and cross-price elasticities with other means of transport as well as positive and negative externalities. Five country cases (Sweden, Japan, New Zealand, Australia, and the United Kingdom) are analyzed according to the structure-conduct-performance paradigm. In respect to competition, he describes drivers of price competition and competition on speed, punctuality, and other services.

Seabright (2003, p. 61) provides an explanation of why a low market share of a new entrant is not necessarily a sign of market failure. He introduces a model that depicts an incumbent train operator and a new entrant. While the new entrant and the incumbent have to bear the same marginal costs for operating any train, the incumbent additionally bears an opportunity cost, induced by connecting routes to which some passengers might transfer. This opportunity cost turns negative if transferring passengers to a connecting route yields a profit. The network effect thus decreases the incumbent's true costs and leads to a lower equilibrium market share of the new entrant if the network effects are large. The following figure illustrates Seabright's reasoning.

Figure 1: Network effects in the rail industry



Source: Seabright (2003).

According to the author, it can be concluded that meshed networks like the German rail transport grid bear greater cost advantages for the incumbent than networks with more O&D connections, e.g. the French system. Furthermore, the so-called "Mohring effect" (Small 1992), which relates waiting time for passengers and the frequency of services to waiting costs and operational costs, suggests that in Seabright's model the assumed initial cost advantages of the new entrant are gradually eroded as it increases its number of services.[4] Although based on a fairly straightforward structure, Seabright's model explicitly integrates the network advantages into market share projections and can be applied to new entry into a meshed network like the Railteam co-operation, where allied, meshed incumbents compete with new entrants operating on specific O&D routes. The author also questions the rationale of economies of scope in a network system and argues that a point-to-point connection may actually be less costly than a connection via multiple nodes because of increased interconnection costs, including the physical connection but also planning and organization of the network. However, he argues that a single-operator mode may have substantial advantages over a combination of several O&D connections in respect to the preferences of passengers, especially under when it comes to convenience. In the situation of direct competition between a possibly more expensive direct connection stretching over several nodes and a cheaper service requiring passengers to switch between different means of transportation, customer preferences may keep market shares for new entrants unexpectedly low (2003, p. 64).

The papers by Villemeur, Ivaldi, and Pouyet (2003) and Seabright (2003) do not contain an empirical section testing their new-entry models. While this paper remains an entirely theoretical treatment of the topic, Seabright (2003: 39) provides a survey on the existing literature treating the efficiency gains of

4 Seabright writes (2003:61): "It is likely that the Mohring effect means that the opportunity cost element will become more important as the entrant's market share increases, since the reduction in the value of frequency of service to passengers becomes progressively more important as the frequency itself declines. The cancellation of half the services is more costly to passengers if services previously ran every two hours than if they ran every fifteen minutes."

vertical integration. In particular, Mizutani and Shoji (2001) report that vertically separated rail companies have a 5.6% higher cost than integrated firms. On the contrary, Shires and Preston (1999) observe a reduction of operating costs by 10% after the reform and vertical separation in Sweden. Seabright comments that all in all the results of the empirical literature remain inconclusive, especially because the effects of vertical separation are often intermingled with more general effects of regulatory reform and industry restructuring. With respect to horizontal integration, the author suggests that a system with "feeder" lines, i.e. connecting services as opposed to mere point-to-point routes, bears important advantages in meshed networks, which is one of the reasons why new low-cost entrants would first target lines with high point-to-point traffic (Seabright 2003, p. 43).

Besides the two papers discussed above, the relevant literature on intramodal competition contains a range of empirical surveys and studies. For example, Lalive and Schmutzler (2008) use a difference-in-difference approach to test changes in the frequency of train services in Baden-Württemberg. They set up different criteria to define train lines with and without competition and find that between 1994 and 2004 lines with competition enjoyed a stronger increase in the frequency of trains than those without competition. They also argue that the stereotype of having only "lemons", i.e. unattractive connections, free for competition does not hold in the case of Baden-Württemberg.

The "Railimplement" study by Steer Davies Gleave (2005) analyzes the success of the implementation of first and second EU railway packages, following Directive 2001/12/EC, Directive 2001/13/EC, and Directive 2001/14/EC. The study addresses several topics related to competition, including the state of implementation of the railway packages in the member states, some general indicators of market development, and institutional obstacles to competition such as barriers to entry. The authors base their findings on collected stakeholder views and secondary data. The study concludes that important barriers to liberalization include legal barriers as well as fundamental differences between railway networks. In addition, technical barriers exist in the form of a minimum efficient size of operation, some of which may result from administrative costs or constraints on methods of working imposed by legislation. The study concludes that it remains for the Community and the Member States to assess their policy priorities and that there will sometimes be tensions between rail market opening and other policy objectives.

Holvad, Preston, and Huang (2003) review railway reform in five countries: Denmark, France, Germany, Sweden, and the United Kingdom. They distinguish between capital market competition, which concerns rail company ownership models, and product market competition, ranging from pure monopoly to perfect competition. They find that the United Kingdom has gone farthest in both dimensions, but—in respect to regional services—Germany has already entered a state of oligopoly in the product market scale. In addition, they observe that labor productivity and service provision efficiency have increased in all countries, while capital (infrastructure) productivity—with the exception of the UK—has remained fairly stable over time.

There is also a growing literature on high-speed rail, for example the empirical paper by Campos, De Rus, and Barron (2006), which analyzes a database with a total number of 40 existing and 126 planned HSR projects around the world. The authors provide a categorization of HSR and compile information on costs of building the new infrastructure as well as on operation and maintenance of the lines. They do not detect an effect of cost decreases in countries that have been operating HSR for a long period, but relate the costs to individual line specificities like geographic features, e.g. the degree of population density along the tracks.

Economies of scale, scope, and density, which may be particularly apparent in vertically integrated companies and network industries, are the topic of numerous papers and publications. They will become relevant for the comparison between point-to-point transportation service providers and vertically integrated network incumbents in the final report's analysis of intramodal competition. In general, economies of scale exist when the average cost curve slopes downward as output increases. Oum et al. (1999) provide a general overview of papers related to productivity and economies of scale. NERA (2000) examine economies of scale between 1986 and 1998 for 9 US class I railroads and find a significant, positive scale coefficient in their models. In contrast, in a study on productivity and economies of scale and scope Cantos Sánchez (2001), analyzing 12 European railway companies between 1973 and 1990, finds diseconomies of scale in many companies, i.e. they may be too large, but also detects important economies of scope, which relates to the joint operation of infrastructure and rolling stock. Economics of scope are further investigated by Growitsch and Wetzel (2006). The authors conduct a cross-country analysis to investigate the performance of European railways in a dataset consisting of about 50 railway companies from 27 European countries between 2000 and 2004. Their models suggest that integrated railway companies are on average relatively more efficient than "virtually" integrated companies, and more than two thirds of the railway companies observed exhibit economies of scope. Ivaldi and McCullough (2004) report similar results for 22 US class I freight railways from 1978 to 2001. According to McGeehan (1993) and Keeler (1974), if the network configuration is held fixed, then economies of scale resulting from increased traffic volume are defined as economies of density. Economics of density measure the relationship between unit costs and the intensity of utilization of capacity. In his study, McGeehan (1993) finds that e.g. the Irish CIE rail indeed observes positive economics of density.

In general, the literature on intramodal competition points to the fact that economies of scale and density as well as network effects may affect entry in a negative way. In particular, meshed networks like the German rail transport grid may bear greater cost advantages for the incumbent than more radial networks, thus reducing the likelihood of entry. Other studies, however, suggest that European rail incumbents may suffer from diseconomies of scale, which would offer opportunities of entry to new and more efficient operators.

2.3 Intermodal competition

The literature on intermodal competition has increased over the last couple of years. The existence of this fairly new field of research can be related to two factors:

- an expansion in the high-speed rail network across Europe;
- the emergence of low-cost air carriers and subsequent price decreases by traditional airlines.

While particularly for business travelers high-speed trains have been able to become competitive with planes in respect to traveling time, low-cost airlines have made flights affordable for leisure travelers and often represent an inexpensive alternative to traditional trips by train. Both factors contribute to a situation where the air transport industry, deregulated during the 1970s and 1980s, has become a competitor with the train industry, still mostly regulated and dominated by state-owned enterprises. Due to this difference of ownership structure (in particular with respect to the grid), pricing strategy, and degree of internationality, broad empirical studies beyond anecdotal evidence have been scarce, mainly due to lack of publicly available disaggregated data and the novelty of the topic. Theoretical treatments mostly stem from the time of regulated services and do not specifically tackle air and rail competition.

One early example is Braeutigam (1979), who develops a model depicting the competition between a regulated service like trains and an unregulated or potentially competitive service like air or road transport. Braeutigam constructs his model on the findings by Baumol and Bradford (1970) and confirms that marginal cost pricing diverts from the optimal financing strategy of the train operator, because it distorts proper balancing of the operator’s budget. He suggests a solution termed "partially regulated second best," where the regulator sets prices only for services with economies of scale, in order to maximize efficiency "subject to conditions which allow that mode to break even" (1979, p. 47), while other services without scale efficiencies are allowed to clear the market in the absence of regulatory intervention. Braeutigam applies his model to freight transport on rail tracks and roads.

While—to our best knowledge—the more recent theoretical literature has not tackled the topic of intermodal competition, several empirical studies have been published. For example, the report "Air and Rail Competition and Complementarity" by Steer Davies Gleave (2006) was prepared for the EC's Directorate General for Transport and Energy. This report examines competition between high-speed trains and airplanes on eight different European lines, including the international connection between London and Paris, as well as several domestic connections in France, Spain, and the United Kingdom.[5] In Germany, the link between Frankfurt and Cologne is examined. The authors provide an analysis of operating costs, as well as several scenarios for market-share evolution until 2016. In respect to operating costs, Steer Davies Gleave finds that rail transport costs per seat and per passenger on all routes are lower than air transport with the incumbent airlines, although on the Paris-London connection the cost difference is minimal because of the high infrastructure charges. However, on five out of eight routes, LCAs operate at lower costs than the train companies. Only on the shortest line analyzed in the report—the high-speed link between Frankfurt and Cologne—does rail transport have lower incurred costs than the LCAs.

Steer Davies Gleave (2006, p. 3) also finds that LCAs have been able to achieve cost savings of around 50% compared to incumbent air carriers and continue to improve their record. In general, all airlines will increase their productivity and obtain further cost savings, while the authors project that railway operators will find cost savings more difficult, mainly due to the high infrastructure costs. However, the authors suggest that better yield management techniques may have the potential to increase revenues significantly.

In the baseline scenario projecting rail and air market shares for the eight routes until 2011, the report finds that on three routes rail market share will decline, on another three routes it will increase, and on two routes it will remain stable. Market-share increase will be induced by the opening of high-speed links (e.g. Madrid-Barcelona and Milan-Rome), whereas losses in market share will be generated by increased competition from low cost carriers (e.g. Paris-Marseille). For the route between Cologne and Frankfurt, market shares remain virtually unchanged.

In addition, the authors attempt to explain market shares through performance and structural indicators. Their main finding is that scheduled journey time is the single most important factor in determining the intermodal allocation of passengers, explaining roughly 84% of the variation in market share between different lines. The authors also propose an indicator termed "generalized journey time" that takes account of both check-in time for the service and the frequency of connections. This indicator explains about 90% of the difference in market shares (Steer Davies Gleave 2006, p. 16). Other factors identified as

[5] In those countries the report analyzes the Madrid-Barcelona, Milan-Rome, London-Manchester, London-Edinburgh, and Paris-Marseille lines.

influencing the market share on individual routes are the time and costs involved in access to terminals, price and ticket conditions, reliability and punctuality, service quality on-board and at terminals, and the availability of alternative (lower cost) modes, e.g. frequent coach services (Steer Davies Gleave 2006, p. 17). The report also indicated that the presence of low-cost carriers on specific routes prompts fare reductions among the incumbent airlines and in some cases affects the pricing schemes of rail operators (2006, p. 28).

IATA Air Transport Consultancy Service's air/rail intermodality study (2003) collects information and opinions from major players (airlines, railways, airports, and passengers) on the development and promotion of enhanced linkages between the European (HSR) services and air transport. The study reports numerous obstacles, for example commercial competition issues related to the different financial objectives in rail and air markets, which prevent effective cooperation, and the fact that successful service integration is reduced by the lack of common information platforms or ticket distribution, although a number of airports, airlines, and railways have made some progress in service integration. The evidence collected in the study suggests, however, that an air to rail transfer potential may be greatest with journey distances between 100 km and 800 km (equivalent to one to three hours by high-speed rail). The authors claim that there is not yet any clear or common perspective among either air/rail operators or passengers on the topic of how HSR and air transport can fit together in an overall European transport network.

Friebel and Niffka (2005) and Antes, Friebel, Niffka, and Rompf (2004) analyze the evolution of intermodal competition in the German transportation market after the entry of 16 low-cost airlines in 2002. Through an examination of market-share development by the German incumbent Deutsche Bahn, the authors claim that inter-modal price elasticities in the relevant literature might underestimate the actual degree of substitutability. In addition, the authors observe a reaction in the pricing strategy of DB, involving a partial imitation of the pricing schemes of LCAs. However, the pricing strategy has been changed only on a small selection of lines, while the overall pricing scheme based on a fixed price per kilometer has remained virtually unaffected. In contrast, the German incumbent air carrier Lufthansa modified its pricing structure on all domestic and many intra-European O&D routes. The authors explain this discrepancy in reaction in terms of a systemic difference between air and rail travel: while the former is a closed system with a defined origin and destination for each passenger, the latter is an open system where passengers can board and leave at any stop. Although the rail network exhibits high fixed costs and economics of density, i.e. the marginal costs per passenger mile at a given network size decrease in traffic volume, which could potentially lead to aggressive yield management techniques in pricing, its characteristics as an open system induce great difficulties in implementing yield management systems. The authors demonstrate that a change in DB's pricing strategy is nevertheless possible for separate companies within the DB holding, for example the "Metropolitan" train between Cologne and Hamburg. After having lost a substantial amount of passengers after the arrival of an LCA, that train line recovered market shares with a different pricing strategy, albeit with lower total revenues. The authors hence conclude that policies designed to foster intramodal competition increasingly have an effect on intermodal competition, and that existing market definitions may have to be re-evaluated (2005, p. 15).

Ivaldi and Vibes (2005, 2007) also opt for a broader market definition with regard to air and rail transport in Europe. They establish a discrete-choice model of transport between an origin and an O&D as a single market with differentiated products. Passengers can choose between several traveling alternatives according to their individual valuations of time, service quality, price, etc. The model further differentiates between business and leisure travelers. Own and cross-price elasticities determine the effect of price changes on the allocation of demand, and a partial equilibrium can be calculated according to any modification in the parameters. The authors apply their model to three competing modes of transport on the Cologne–Berlin route: car, train, and plane or the outside alternative of not traveling; and to two service parameters: price and quality. They calibrate their model with data on market shares, prices, characteristics of transport services, and some values for marginal costs. Several simulations for market configurations are computed, including a control simulation of the entry (and exit) of train operator InterConnex on the route, the arrival of LCAs, and an increase in different transport-related taxes. According to the authors, the counterfactual experiments and simulations suggest that a small number of competitors already suffices to create strong competition on an intermodal level.

Carried out on behalf of the Spanish government, the study by Lopez-Pita and Robuste-Anton (2003) is motivated by the effort to find a solution to slot scarcity at airports. The study takes substitutability of train rides for short or middle-distance, domestic or intra-European flights for granted. The authors argue that air-rail connectivity with railway stations located at airports can serve to terminate uneconomical plane routes like Cologne-Frankfurt (2003, p. 49), while the additionally available flight slots can be used for the reduction of flight delays. They provide estimates of the slots potentially made available by the withdrawal of short-haul flights from major European airports. In a related paper (Lopez-Pita and Robuste-Anton 2005), they more closely examine the impact of the opening of high speed rail tracks on the Madrid-Barcelona route. Based on a model of generalized costs for car, plane, and high-speed train travel and several assumptions regarding elasticities, they calculate the expected allocation of passengers after the introduction of the new line and compare it to figures calculated by airline incumbent Iberia. The authors conclude that high-speed trains are likely to succeed planes as the dominant means of transportation on the route, with a market share increasing from the current 11% to 50-60%.

In sum, the scholarly literature and consulting reports that discuss air and rail transport do not question the *existence* of intermodal competition, but rather attempt to measure or model the *degree* with which intermodal competition occurs. Most studies come to the conclusion that rail and aviation have increasingly converged into one market, both in the perception of customers with respect to travel time as well as in the strategic interaction between train and plane operators.

2.4
Alliances

To our best knowledge, no empirical studies of alliances in the railways have been published. This absence of relevant literature can easily be linked to the novelty of the business concept within the context of the sector's gradual liberalization and the cautious opening-up spurred by the EU directives. Although alliances between railway companies have in fact existed for decades, they were mainly governed by standardized models of participation on the basis of capital costs. More recently, on the EC-lines there has been an evolution from profit-sharing according to UIC standards to joint ventures, with non-standard components integrated into the contract.[6] At the same time, joint marketing subsidiaries of the big railway operators have been founded to promote specific lines. A critical evaluation of these strategic but very limited partnerships is still pending.

Alliances have, however, been the focus of empirical evaluations in a different network industry: in the mid- to late 1990s, airline operators started to form global partnerships, including an extension of already existing code-sharing agreements into strategic co-operations, parallel and complementary alliances, and an increasing amount of partners within the networks. The three biggest alliances, Star Alliance, OneWorld, and Skyteam, with market shares of global air passenger transport of, respectively, 28.1%, 18.4% and 29.1%, count between 11 and 20 members each.[7]

The literature on alliances consists of theoretical, empirical, and simulation-based studies and papers. For example, in a simulation model Brueckner (2001) evaluates the benefits and disadvantages of alliances, particularly with respect to inter-hub passengers; he comes to the overall conclusion that alliances generally increase both consumer surplus and total surplus. A more critical appraisal of the impact of co-operations is found in the analysis by Brueckner and Pels (2004) of the Air France-KLM airline merger, which might have also led to a consolidation between airline alliances. The authors estimate that the merger's

6 Interview at Deutsche Bahn AG, January 22, 2008.

7 Information from company website of the Star Alliance Network, Facts & Figures, as of December 2007.

anti-competitive effects translate into lower consumer surplus. Similarly, Armantier and Richard (2005) investigate the welfare consequences of the code-share agreement between Continental and Northwest Airlines and find evidence of higher passenger volumes and lower prices across markets in which the two airlines are code-sharing. However, the authors also uncover significantly higher prices across markets with nonstop flights run by both airlines, suggesting a type of "waterbed" effect.

In any case, the literature on airline alliances draws an overall positive conclusion regarding consumer benefits. Most empirical studies find a price decrease of up to 25% due to the presence of an alliance. The following table provides an overview of the estimated achieved cost reductions.

Table 2: Reduction of average air fares due to alliances as indicated in various studies

Author(s)	Reduction by	Relevant market/alliance partner	Published
Ito and Lee	**12%**	Domestic USA	2007
Bilotkach	**23%**	Transatlantic Code-Sharing	2005
	10%	Transatlantic Alliances	
Bamberger, Carlton and Neumann	**8%**	Continental/America West	2004
	4%	Northwest/Alaska	
Whalen	**11%**	Transatlantic Code-Sharing	2003
	19%	Transatlantic	
Brueckner	**8%-17%**	International Code-Sharing	2003
	13%-21%	International Immunized	
Brueckner and Whalen	**25%**	World	2000
Park and Zhang	**$41**	Transatlantic Alliances	1998

Source: ESMT CA.

2.5 Implications and conclusions

The major conclusions that may be drawn from the preceding literature review can be summarized as follows:

Seabright's (2003) analysis of the network effects of incumbent rail operators vis-à-vis new entrants circulating on O&D routes demonstrates that the incumbents' negative opportunity costs in meshed systems may lead to lower than expected market shares for new entrants. His model indicates the importance of both network effects and the access of entrants to the network. The model also implies that new entrants may face obstacles to attracting passengers. However, the actual customer shift between incumbents and new entrants hinges, crucially, on customer preference regarding traveling convenience versus cost savings. Both Seabright models can be applied to types of alliances and cross-border co-operations, where a meshed network with allied incumbent operators is able to offer the full advantages of integrated journeys to the less cost-sensitive and more convenience-oriented customers traveling via several nodes of the system. These advantages for incumbents suggest that the commercially viable launch of new entrants on the European high-speed rails may well be less than anticipated by the EC.

According to Villemeur, Ivaldi and Pouyet (2003), the strategy applied by efficient incumbent rail operators of targeting the high-speed sector is economically rational, because this segment will remain the most profitable option under the threat of competition and the emergence of new entrants. In addition, alliances like Railteam lead to a preferable situation for European travelers because it can offer a product of trans-European dimensions corresponding to the high-end customer demand for convenience. The negative implications of market power are thus counterbalanced by the efficiency-enhancing effects of the alliance. Alliances and co-operations may thus create significant welfare effects from bundling services and increasing passenger quality (frequency, etc.).

Many studies and reports on intermodal competition, including Steer Davies Gleave (2006), Ivaldi and Vibes (2005, 2007), Friebel and Niffka (2005), Antes et al. (2004), and Lopez-Pita and Robuste-Anton (2003, 2005), confirm that intermodal competition between rail and air transport exists and is increasing, especially with the rise of low-cost carriers. For a European market of passenger transportation, these studies suggest that sufficient competition with airlines effectively constrains rail companies, both in their national territory but even more strongly when they participate in loose alliances taking in greater travel distances, and ensures that consumers receive a fair share of economic benefits from any alliance: this is so because intermodal competition prompts cost reductions to be passed on and have an impact on prices.

A representative sample of the most recent literature on airline alliances indicates that the majority have had welfare-enhancing effects. Only a few cases have been identified and empirically investigated where alliances may have had detrimental consequences for consumer welfare. The major effects of the alliances, in particular the removal of the double-marginalization externality, efficiency gains, and the expansion of networks and flight frequencies, are manifest with alliances in other sectors as well. However, one of the major differences between the existing airline alliances and rail co-operations is that in the most important market segments, such as transatlantic flights, at least two alliances are direct competitors, whereas loose alliances like the newly established Railteam co-operation do not face any competing alliance on the rail tracks, but rather are confronted with competition from air carriers and individual vehicle transport. Hence the structural difference is that effective competition in aviation is mainly catalyzed by intramodal competition *between* alliances and *with* low-cost carriers, while in the railways intermodal competition may represent the major impetus for price reductions and quality improvements. Our subsequent panel data analysis suggests that competitive pressure exerted by low-cost airlines indeed has an effect on rail operations.

3. The regulatory environment and recent decisioins

The following section provides an overview of the regulatory environment within which competition in European long-haul passenger transport will emerge, both on a European level as well as in the perspective of the German competition authority (Monopolkommission), and surveys past assessments and decisions by competition authorities with respect to the rail and aviation industry. Two of the most important decisions in this field, the recent Ryanair/Aer Lingus case and the British Airways/Eurostar case, are then described in more detail.

3.1 The ongoing liberalization process

In March 2004, the European Commission adopted legislative proposals for the so-called Third Railway Package. The package consists of a proposal for a regulation on passenger rights, a proposal for a directive on certification of train crews and a proposal for a directive on liberalization of rail passenger transport.

The commission's approach on liberalization of rail passenger transport foresees opening up infrastructure access to operators wishing to provide international services. This model mainly targets long-distance services where, according to the commission, commercial innovation is likely to attract new customers. This free infrastructure-access model may be implemented on the high-speed trans-European network,[8] supposedly to be linked up by 2010, and could provide scope

[8] However, it is not limited to high-speed operations only.

for the appearance of new competing services. More specifically, under the proposal all international services would be opened up to competition on January 1, 2010. The commission further states that this opening-up also includes cabotage on international services (carriage of passengers between two places within the same member state) allowing Member States the option of limiting such access if they conclude the economic equilibrium of the public service contract is at risk.

Following the adoption of the proposal on liberalization of rail passenger transport by the European Commission in 2004, the European Parliament, in the first reading in September 2005, voted for a more ambitious approach towards liberalization: liberalization of international passenger transport from January 1, 2008 and liberalization of domestic passenger services from January 1, 2012. The Council, however, in its Common Position in the first reading in July 2006 rejected the Parliament's approach and—in line with the Commission proposal—only accepted the opening of international passenger transport by January 1, 2010. Furthermore, the Council introduced a stricter definition of "international traffic" ("principal purpose" of the service must be the carriage of passengers between stations located in different Member States) and an additional safeguard for public service transport: the member states' right to charge a levy on international rail passenger services in order to contribute to the financing of public service transport. The levy is subject to a cap, such that the levy must not threaten the economic viability of the entrant. In addition, the Council introduced the possibility to limit the access in the case of existing exclusive rights on the same track. In the second reading, the Transport Committee of the Parliament stuck to its more ambitious approach and voted for liberalization of international passenger transport from January 1, 2010 and liberalization of domestic passenger services from January 1, 2017. Furthermore, it rejected the Council's idea of a stricter definition of international transport. In the plenary session in the second reading in January 2007, however, the qualified majority for the Committee's report was missed and the Parliament accepted the Council's timeline limiting liberalization to international passenger transport. After a conciliation procedure the Third Railway Package was adopted by the European Parliament and the EU Council in the third reading in September and October 2007. The legal acts of the Third Railway Package were then published in the Official Journal n° L 315 of December 3, 2007. The directive on liberalization of rail passenger transport now foresees liberalization of international services as of January 1, 2010, including cabotage. The "principal purpose" of the service must be the carriage of passengers between stations located in different Member States. The access can be limited if the economic equilibrium of a public service transport is compromised and in the case of exclusive rights granted before December 4, 2007. Member states may impose a levy on international services to finance public service transport, but which must not endanger the economic viability of the international service.

3.2
Market definition in the railway transport cases

The introduction of the Third Railway Package has been preceded by multiple interventions of European and national authorities in the regulation and issues of competition policy of the rail transportation sector. Especially in questions of competition policy, one of the major issues that has emerged in those cases is the definition of the relevant market. While in older cases[9] the commission defined the relevant geographic area by reference to the extent of the network comprising the railway routes, stations, and depots, whose operation is the subject of the franchise agreement,[10] the more recent cases comprise individual point-to-point routes since no such route is demand-substitutable for another.[11]

From the demand side, the relevant product market could be formed by all passenger transport services, including airlines, buses, and taxis, or only by rail services. In the case of a railway service franchise, the commission recognized that competitive pressure might be exerted by other types of public transport, including buses.[12] However, other modes of transport were considered complementary modes of transportation, hence outside the relevant market, or were treated as insignificant in competition terms.[13] In some cases, the exact definition of the relevant product market was left open, since either the transaction was requested by parties with significantly small market shares[14] or no competition concerns could arise.[15] Most of the cases that the European Commission has dealt with to date concern transportation in the United Kingdom, where deregulation and liberalization of the railways started much earlier than in continental Europe; for this reason the applicability of these cases to the German context is somewhat limited.

While recent decisions by the competition authorities lack a comprehensive assessment of the relevant antitrust markets and potential anti-competitive effects in the passenger railway markets, a recent special report by the German "Monopoly Commission" (Monopolkommission, MK) advisory body covers those issues more broadly. The report will be summarized in the following section.

3.3
Asessment by the Monopolkommission

In its special report concerning the German rail sector,[16] the MK distinguishes between three different categories of travelers—business travelers, leisure

9 A list of all relevant railway transport cases is provided in appendix 3.

10 European Commission: case M.901 – GO-AHEAD/VIA/THAMESLINK; case M.816 - CGEA/South Eastern Train Co Ltd; case M.748 - CGEA/Networks South Central.

11 European Commission: case M.2446 - Govia/Connex South Central.

12 European Commission: case M.901 – Go-Ahead/VIA/Thameslink; case M.816 - CGEA/South Eastern Train Co Ltd.

13 European Commission: case M.2446 - Govia/Connex South Central.

14 European Commission: case M.4070 – London South Eastern Railway/The Integrated Kent Rail Franchise.

15 European Commission: case M.3554 – Serco/NedRailways/Nothern Rail.

16 Monopolkommission 2007: Wettbewerbs- und Regulierungsversuche im Eisenbahnverkehr, Sondergutachten gemäß Paragraph 36a.

travelers, and holiday travelers—with respect to market definition and intermodal competition. Concerning intermodal competition with cars, the commission assumes that holiday travelers are a separate market with fixed preference sets ("habitualization"). With respect to business travelers the preferred transportation means for business travelers having to reach destinations between 100 km and 350 km away are, according to the commission, trains. The commission assumes that for this customer segment individual car trips are not suitable, because business travelers want to reach their destinations with the comfort of rail travel and without traffic jams. In its analysis of intermodal competition with air travel, the commission distinguishes between distances of between 100 to 350 km and those of between 350 km to 700 km. In the first distance-segment, air travel plays a limited role at the most: that of the "spokes" in the hub-and-spoke systems of incumbent airlines. The rise of low-cost carriers in that distance-segment is of lower importance, since the airports that LCAs target are usually far away from urban centers and thus, especially for business travelers, are not particularly appealing. The commission thus concludes that for distances below 350 km, air travel does not significantly compete with rail travel. For distances over 500 km, however, the advantage of a higher speed level makes aviation the preferred transportation means, especially for business travelers. Accordingly, the MK sees the greatest effect, and a single market of train and planes, in the distance segment between 400 km and 600 km—the segment including, for example, the trips between Berlin and Cologne (540 km), Hamburg and Cologne (410 km), and Düsseldorf and Munich (530 km). Although the commission states that low-cost carriers have been successful in gaining market share vis-à-vis the incumbent, network-based airlines, and the charter flight companies, the impact of LCAs has been less severe in the framework of DB passenger numbers in the relevant, 400-600 km distance. The MK argues that when looking at overall quantities of LCA seat capacity, any impact of the LCAs has to be considered small when compared to the seat capacity of trains. However, given an average seat utilization ratio of 42% in the DB long-distance traveler segment, the salient question appears to be whether seat capacity or actual passenger numbers represents the correct indicator for comparison. This study proposes a more refined analysis, based on quantitative methods moving beyond mere capacity-counting, in order to assess the actual impact that low-cost airlines have on train passenger numbers.

The overall conclusion of the MK's market definition is that there is a kilometer range where trains and planes are likely to compete, but that the German incumbent rail provider overstates and somewhat exaggerates the effect that low-cost airlines exerts. Put into the larger context of Deutsche Bahn as a differentiated company, low-cost airlines directly affect only a very limited segment of the company's business lines and are, in general, not operating in the same market.

According to the special report of the Monopolkommission, intramodal competition in the long-distance passenger transport sector basically does not exist in Germany, given the market share of competitors hovering at around 0.4% in terms of passenger kilometers. In the MK's view, as opposed to, for example, the situation in the freight sector, the two major reasons for the lack of competitors in this sector are the high barriers to entry and low level of attractiveness of the markets. In contrast to regional or municipal services, where a public administration opens tenders or franchises for public (short-distance) transport services—considered part of the set of basic infrastructure services provided by the authorities and sometimes even remunerated through long-term contracts irrespective of actual passenger numbers—long-distance passenger services can only rely on revenues generated by travelers. The MK indicates that these revenues are only sufficient on a few highly frequented routes. In addition, political regionalism forces high-speed trains to stop too often, thus increasing operating costs and travel time while not properly exploiting the cost-intensive high-speed infrastructure, consequently deterring potential competitors from entering the market. For the MK, entry into the long-distance rail segment of international O&Ds is still negatively affected by several factors, including differing national regulations used as a means of protectionism and hurdles in the interoperability between national standards and different technical systems. In addition, the commission states that rules for profit-sharing between former national monopolists would prevent services of different incumbents from competing. However, the MK is cautiously optimistic that there is the potential for at least a "partial strengthening" of intramodal competition after 2010, due to the planned reduction of entry barriers initiated by Brussels. But the commission assumes that without orders and tenders from the public authorities, only a limited number of offers on profitable long-distance services will exist, and correspondingly, that only a small market potential will be present.

As indicated, the MK sees the existing high economic barriers to entry as the second factor producing the low potential for competition in long-distance rail passenger transport. The MK points to the high capital costs of specific, i.e. tailor-made rolling stock, in combination with an enduring lack of a functioning pool for locomotives and wagons. Investments needed to set up systems of customer information and retail services are also substantial, themselves creating barriers to entry. Entrants may face difficulties in getting time slots in intervals between the scheduled and network-optimized services. The commission states that Deutsche Bahn is able to benefit from its size, the resulting network externalities translating into a competitive advantage for the incumbent, in particular because DB is able to offer connections, numerous transfer possibilities, and combined ticketing on the long-distance, regional, and even municipal level. The transfer passengers also positively affect the load factor of DB trains, whereas entrants may not be able to attract these customers because of incompatibility of ticketing or scheduling. Apart from the primary network benefits, the incumbent also owns a secondary network comprising cleaning infrastructure, storage capacities, etc. Potential competitors typically have to buy these supplementary services from DB. As a further source of entry barriers, the commission's experts identify the informational advantage enjoyed by the incumbent, i.e. its experience and knowledge regarding relevant customer demand patterns; these have to be acquired by entrants through costly market research.

The above-outlined factors lead the MK to conclude that there is hardly any potential for market entry on international routes or in highly meshed networks. However, the MK lists six market segments where its experts believe competition is not entirely unlikely:

i. Impulses for competition may emerge if incumbents from neighboring countries such as SBB, ÖBB, and SNCF decide to enter.

ii. Smaller operators and independent entrants could potentially target selected point-to-point services during peak traveling times (mornings and evenings) between demographically important load centers such as urban agglomerations.

iii. The commission envisions an ability by newcomers to profitably provide selected market niches such as seasonal or chartered services.

iv. Direct competition with DB trains could emerge on longer O&Ds, where providers of lengthier and slower low-cost services, for instance InterConnex trains from Leipzig to Berlin and Warnemünde, may target the less time-sensitive traveler segment.

v. On routes where DB has ceased providing InterRegio services, especially between medium-sized cities or between medium-sized and larger cities, the existing demand can be met by new entrants capable of running trains more profitably than DB due to relative cost advantages, enhanced quality management, and targeted marketing efforts.

vi. Operators active in regional transportation under long-term contracts with municipalities may be able to extend their services from the local environment to longer trips, as the case of Vogtlandbahn demonstrates.

In the following, we review the market definition assessment applied in the various airline transaction cases. These cases are not only relevant to this study because of its intermodality aspects but also because the insights derived from the decisions can to some extent be transferred to the question of railway market definition. Two cases with particular importance for the rail transport sector are presented in detail.

3.4 Market definition in the airline transport cases

The origin and destination approach to market definition has been a starting point for competition analysis in air transport cases;[17] it has also become increasingly relevant in the assessment of intermodal competition. Within this approach, every combination of a point of origin and a point of destination is considered a separate market from the consumer's point of view. The O&D approach is thus a demand-based approach to market definition. It is applied by both the EC and the national competition authorities.

Product characteristics

The European Commission distinguishes between different products in airline competition; these can to some extent be applied to intermodal competition as well. For example, the commission examines the characteristics of air services, distinguishing between the supply of airline seats directly to passengers and the supply of package tours by tour operators (charter), because these services are not substitutable as prices and conditions are different.[18] In particular, the EC's conclusion results from the fact that tour operators combine air transport service with other services such as hotels. Consequently, package tours provided by tour operators are excluded from the relevant market. However, non-packaged train travel and air travel share product characteristics such as booking procedures, point-to-point journeys, and different classes of travel (leisure, business).

Consumer characteristics

When taking a demand-based approach to market definition, it seems necessary to distinguish between different groups of passengers, given that different services may be substitutable for different kinds of customers. Distinguishing between these groups reflects the established practice of the European Competition Authorities.

Time-sensitive vs. non time-sensitive passengers

In the case of airline consumers, the EC has traditionally distinguished between time sensitive passengers, mostly business travelers, and non-time-sensitive passengers, mostly leisure travelers. The reason for this has been to narrow the market to direct flights, since as a distinct group time-sensitive business passengers cannot rely on indirect flights. However, at least in regard to transatlantic routes the commission has re-evaluated its opinion, its investigation having revealed that on these routes the line between passenger categories becomes increasingly blurred.[19] This is because an increasing number of business passengers travel economy class, the choice of airlines being made on the basis of corporate discounts instead of travel time. Since the question of whether there is a distinct market for time-sensitive passengers was not decisive for its market assessment, the commission decided to leave it open, concluding that

[17] A list of all relevant air transport cases is provided in appendix 4.
[18] European Commission: case M.2041 – United Airlines/US Airways.
[19] Ibid.

competitive indirect flights could be viewed as substitutes for non-stop flights, at least in the United Airlines/US Airways case.

Point-to-point vs. connecting passengers

The existence and number of connecting passengers have been important factors in assessing competition on a specific O&D route in several cases, although they have not been the main focus of the analysis. In contrast to the situation of O&D (point-to-point) passengers, for connecting passengers a flight between two airports forms only part of the plane-travel, and the airport where the connection is made is neither the point of origin nor the point of destination. Since connecting passengers have a wider choice of flight alternatives than O&D passengers they may thus belong to different relevant markets. In its decisions the EC differentiates between point-to-point passengers and connecting passengers in relation to the relevant O&D routes.[20] Connecting passengers and O&D-passengers are considered as belonging to different relevant markets. In addition, in both the Air Canada/Canadian Airlines case[21] and the British Airways/City Flyer Express case,[22] the UK Competition Commission analyzed connecting passengers as separate markets. In contrast, in the Lufthansa/Eurowings case,[23] the Bundeskartellamt considered point-to-point passengers and connecting passengers as belonging to the same relevant market. In any event, the effects of connecting traffic should be taken into account in the overall competition assessment of affected O&D routes.

Demand substitution

In order to establish whether an O&D pair forms a relevant market, the competition authorities consider the different possibilities offered consumers to travel between these two points.

Indirect flights

The question of the extent to which indirect flights should be included in the relevant market had to be answered in the light of demand substitution. Customers may consider direct flights (i.e. non-stop services) and indirect flights (i.e. one-stop services) as substitutable transport options. In general, indirect services are more likely to be substitutable for direct services on long-haul flights than on medium or short-haul (e.g. domestic) flights.[24] Furthermore, for competition policy purposes only indirect flights offered by independent competitors can be considered a competitive alternative for passengers. Against this background, the extent to which indirect flights are substitutable for direct flights in an individual case can only be assessed on a route by route basis.

With respect to long haul routes the European Commission concluded in the United Airlines/US Airways case[25] that indirect routes may constitute a competitive alternative to non-stop services if they meet the following

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[20] European Commission: case M.2041 – United Airlines/US Airways; case 37.730 - Lufthansa/Austrian Airlines.

[21] UK Competition Commission: case Cm 4838 - Air Canada/Canadian Airlines.

[22] UK Competition Commission: case Cm 4346 – British Airways/City Flyer Express.

[23] Bundeskartellamt: case B9-147/00 – Lufthansa/Eurowings.

[24] OFT: case CP/1535-01 – British Midland/United Airlines. European Commission: case M.2041 – United Airlines/US Airways.

[25] European Commission: case M.2041 – United Airlines/US Airways.

conditions: they must be marketed as connecting flights to be taken on the city pair concerned (and thus appear on the computer reservation system) and they may only result in a limited extension of journey duration. In the Lufthansa/Austrian Airlines case,[26] it was maintained that in the presence of short distances involving a short travel time, only very few non time-sensitive travelers would consider replacing a direct flight by an indirect flight as a result of a price increase for direct flights, and that this share of passengers was too small for indirect flights to exert any competitive pressure on direct short-haul routes. As an exception to this general presumption, in the Air France/KLM case[27] the EC concluded that on two city pairs on the Franco-Dutch bundle (Bordeaux-Amsterdam and Marseille- Amsterdam) the indirect services of Air France did constitute a competitive alternative to non-stop services. That airline's indirect service on these two individual routes was particularly attractive to time-sensitive passengers because it offered a higher number of frequencies in relation to Basiq Air's direct service and thus the only possibility for a one day return trip. In the British Midland/United Airlines case, the OFT considered indirect flights for UK passengers flying to the US, concluding that it was not generally an attractive option to fly indirectly via another airport in Europe - an indirect flight via another US gateway was considered a more attractive alternative.

Alternative modes of transport

In several cases, high-speed rail transport has been considered a possible intermodal alternative to air travel for time-sensitive passengers. Generally speaking, though, in the EC's view, whether certain alternative modes of transport belong to the same product market can, in each individual case, only be assessed on a route by route basis.

In the European Night Services case[28] the EC demonstrated that the substitutability of different transport modes depends primarily on the needs of a particular group of travelers. In this decision, two relevant service markets were defined: the market for the transport of business travelers and the market for the transport of leisure travelers. On the other hand, in the Lufthansa/Austrian Airlines case,[29] the EC found that in addition to qualitative factors, total traveling time rather than distance is the decisive factor for consumers when it comes to transport substitutability. The commission concluded that on direct routes between Germany and Austria other means of transport such as rail and road usually do not offer an alternative for time-sensitive travelers. In the British Airways/SN Brussels Airlines case,[30] the commission found that the relevant market in the Brussels O&D pair was broader than direct air services and included high-speed rail transport (i.e. Eurostar). Rail was considered a competitive alternative to air transport for both non time-sensitive and time-sensitive passengers. In the British Airways/City Flyer Express case,[31] the UK Competition Commission found that particularly on domestic routes and the European routes

[26] European Commission: case 37.730 - Lufthansa/Austrian Airlines.

[27] European Commission: case M.3280 – Air France/KLM.

[28] European Commission: case 34.600 – European Night Services.

[29] European Commission: case 37.730 - Lufthansa/Austrian Airlines.

[30] European Commission: case 38.477 – British Airways/SN Brussels Airlines.

[31] UK Competition Commission: Cm 4346 – British Airways/City Flyer Express.

to Brussels and Paris (served by Eurostar), rail services operated in the same market as airlines. However, in the Lufthansa/Eurowings case,[32] the German Bundeskartellamt concluded that there is (still) no homogenous market for land- and air-based transport for German domestic traffic.

Airport substitutability: Geographic scope
The relevant market also has a geographic scope, which includes flights operating from airports whose catchment areas significantly overlap with those of the airports concerned. Those passengers living in the catchment areas of two or more airports (i.e. "overlapping catchment areas") may consider all of them when choosing which airport they fly from and which airport they fly to.

The substitutability of airports has been an important issue in a number of cases. In the United Airlines/US Airways case,[33] it was found that flights from the Munich and Frankfurt airports to US cities were not competitively constrained by flights from either regional airports or certain European hub airports (i.e. Amsterdam, Brussels, and Zurich) on almost all city pairs concerned.

In the British Midland/United Airlines, British Airways/City Flyer Express, and Air Canada/Canadian Airlines cases,[34] the UK competition authorities addressed the question of airport substitutability with respect to the main London airports (Heathrow and Gatwick) and the vicinity's "secondary" airports (Luton and Stansted). In the British Airways/City Flyer Express case, it was noted that catchment areas for short haul routes tended to be narrower than those for long haul routes and that airports were less dependent on their main catchment areas for leisure travelers than for business travelers. In general, at least for time-sensitive passengers Luton and Stansted are considered non-substitutable secondary airports.

3.5
The Ryanaira/Aer Lingus case

Overall decision
On June 27, 2007, on the basis of the EU Merger Regulation, the European Commission prohibited the proposed takeover by Ryanair of Aer Lingus.[35] The commission found that the acquisition would have combined the two leading, and vigorously competing, airlines operating from Ireland. It concluded that the merger would harm consumers by removing the competition and creating a monopoly or dominant position on 35 routes operated by both parties. The ensuing reduced choice was likely to lead to higher prices for the more than 14 million EU passengers using these routes to and from Ireland annually. The EC's investigation and market testing of remedies offered by Ryanair demonstrated that the remedies were not sufficient to remove the competition concerns. In

[32] Bundeskartellamt: case B9-147/00 – Lufthansa/Eurowings.

[33] European Commission: case M.2041 – United Airlines/US Airways.

[34] UK Competition Commission: case Cm 4346 – British Airways/City Flyer Express; case Cm 4838 - Air Canada/Canadian Airlines. OFT: case CP/1535-01 – British Midland/United Airlines.

[35] European Commission: case M.4439 – Ryanair/Aer Lingus.

particular, the limited number of airport slots offered was unlikely to lead to competition adequately replacing the mutual competitive pressure currently at work between the two airlines. The commission thus concluded that the concentration would significantly impede effective competition in the European Economic Area or a substantial part of it.

Market definition assessment

The factual situation in this case was significantly different from that in all previous airline mergers assessed by the EC, notably because for the first time the case concerned a merger of two "low-cost" point-to-point airlines, both of which had significant operations at one and the same airport.

- Previous airline cases dealt mainly with mergers that combined complementary networks and operating models, e.g. network carriers operating with a hub and spoke model and charter/tour operators, network carriers and smaller regional airlines, or, in some cases, two (smaller and larger) network carriers. The present proposed transaction represented the first case in which the commission had to assess a merger combining two airlines that operated according to the low-cost/low-fares business model and were focused on point-to-point intra-European service.
- All previous cases mainly concerned mergers of two carriers that had their main centers of operations at different airports, often in different countries, and raised concerns regarding a relatively limited number of overlapping routes. In contrast, this merger concerned the two main airlines in Ireland, with significant operations at one and the same airport, Dublin Airport, where they were by far the two largest airlines.[36]

Customers and competitors often refer to an “Irish market” and claim that the conditions in this market are, at least to a certain extent, different from conditions in other markets. With a significant presence in Dublin in particular, both airlines are more easily able to switch between routes and add other routes out of the airport than other competitors without such a significant base. From a supply-side perspective, it could thus be argued that the relevant market is defined by considering all flights from or to Ireland, which together form a “bundle of routes”. Emphasizing supply-side substitutability would have the advantage of taking into account competitive factors going beyond the single “O&D”- approach, e.g. the common base in Dublin, the advantage of brand recognition for Irish operators, and the possibility to shift flights between different destinations out of Dublin. However, these exclusively supply-side considerations disregard the fact that from the demand side, passengers are in principle flying a determined route to a determined destination rather than any route anywhere. This is especially important given that the demand side was in principle the commission’s starting point for the definition of relevant markets.

[36] Aer Lingus and Ryanair hold a share of about 80% of all scheduled European traffic from and to Dublin. Around 41 out of a total of around 48 short-haul aircraft of all airlines based in Dublin belong either to Ryanair or Aer Lingus.

To assess the effects of the proposed transaction on passenger air transport services between, in particular, Dublin and cities in which any of the carriers operated hub airports (for example London, Frankfurt, Paris, Madrid), the EC distinguished relevant O&D routes in terms of point-to-point passengers on the one hand, connecting passengers on the other hand. Those passengers traveling point-to-point were seen as likely to be affected by the proposed transaction in that the destinations belonged to O&D pairs with overlapping merging parties' services. In contrast, due to the non-overlap between the services of Aer Lingus and Ryanair on the connecting routes, the EC analyzed connecting flights as separate markets.

To determine the extent to which the merging parties' activities overlapped, substitutability of scheduled air transport services from different airports was also a relevant factor for analysis. According to the "airport pair" approach, Ryanair's activities only overlapped with Aer Lingus's on sixteen routes on which the two carriers flew between the two same airports. An additional nineteen cities were identified to which Ryanair or Aer Lingus fly from Ireland using different airports, with Aer Lingus in most cases using primary and Ryanair secondary airports. For all these city pairs, the commission carried out a detailed analysis to establish whether or not the airports could be considered as belonging to the same catchment area from the consumers' point of view. The main factors were assessed that were seen as relevant for individual customers when considering air transport service to and from neighboring airports as a reasonable alternative; these factors included travel time, travel cost, flight time/schedules/frequencies, quality of service, and combinations thereof. According to the view of the various parties involved, the EC applied the 100 km/1 hour approach as a first proxy to define a catchment area. Due to the specificities of the airports and other evidence regarding time-sensitive vs. non-time sensitive passengers, the catchment area could be wider in reality and was assessed on a case by case basis.

In its further review, the EC based its competitive assessment on an analysis of individual routes between single O&Ds. The Commission did, however, recognize that the single O&D markets were not entirely mutually independent; the commission thus took account of the commonalities between different routes and of supply-side substitutability and other forms of potential competition considerations whenever appropriate.

3.6 The British Airways/Eurostar case

In terms of passengers, the Paris-London transport route is the most important connection between European capitals.[37] Since the opening of the Channel tunnel

[37] See Case 07-D-39 of the Conseil de la Concurrence for further details.

and the introduction of the Eurostar trains, passengers have had a choice between planes, trains, and ferries, the latter form of transport taking in travel by individual cars and coaches.[38] According to the French competition authority (Conseil de la Concurrence 2007, p. 7), air and rail are in direct competition to carry passengers between Paris and London. But there is a substantial difference between the two means of transport: to a considerable degree, Paris-London air traffic is fed by transiting passengers (about half of the travelers), whereas Eurostar passengers are mainly point-to-point passengers. The transiting passengers contribute to the profitability of the participating airline companies along the whole of the route. In addition, the importance of business passengers on the route is substantial.

Between 1995 and June 2000, the passenger volume of the Eurostar rose steadily while the number of flight passengers decreased. From the second half of 2000, the demand for transport between Paris and London experienced a strong contraction because of various unfavorable events. This market degradation was accompanied by operational difficulties after onset of a crisis at British Rail in the winter of 2000, initiated by the Hatfield accident.

British Airways (BA) claims that Eurostar is in a dominant position in the transport market on the Paris-London route, on which rail transport based on the Eurostar must be considered an alternative to direct air routes. The company further claims that Eurostar's tariff and offer policies have a predatory character because Eurostar constantly sets up particularly attractive promotional offers. At the time of the BA complaint, there were for example daily offers of more than 3,200 places at a €35 tariff, which is to say the equivalent of the seating capacity of ten Boeing 747s (Conseil de la Concurrence 2007, p. 3).

Eurostar's tariff policy varies according to the total demand. Tariffs are determined by EGL, the Eurostar operating company, according to the technique known as "yield management," which aims to fix tariffs adapted as precisely as possible to the propensity to pay of potential customers, in order to maximize the load factor and hence the total income by train. The range of prices offered is thus very broad, from the promotional leisure ticket to the full fare business ticket. Those conditions vary not only according to the timing of the journey but also the date of reservation and flexibility offered.

BA states that "the predatory strategy of Eurostar was implemented right from the start since as of its startup in 1994, the capacities of Eurostar were completely disproportionate compared to the demand. This practice of predation and saturation of the capacities was reinforced at the time of the introduction of new tariffs (at the moment of the reduction of the time of way to 2h35). The construction of the new British sections adapted to the fast passage of the trains required huge investments. However, far from increasing its prices, like economic

[38] Ferries are not further considered in the decision: "Other means of transport usable to travel from Paris to London (used in particular by leisure travellers and passengers called "not time sensitive"), e.g. the train or the car associated with the passage by ferry or railway shuttle by the tunnel, lengthen the duration of the trip in a way such that they cannot be regarded as a real alternative to Eurostar or the plane." (Conseil de la Concurrence 2007, p. 18.)

logic would have suggested, Eurostar lowered its tariffs and increased the frequency of its trains (from 14 to 16 per day). In same time, the load factor of the trains remains weak." EGL states, to the contrary, that Eurostar actually reacted with price decreases after BA reduced its tariffs as a reaction to the entry of Easyjet and Ryanair (Conseil de la Concurrence 2007, p. 5).

The French competition authority acknowledges that Eurostar has a dominant position on the Paris-London route.[39] In its further decision-process, however, it offers an analysis of Eurostar's profitability on the basis of average revenues and total variable costs for the company's least profitable train. In particular, it determines the number of average passengers on this train, the variable costs related to the transported passengers, and the variable costs related to the train. The competition authority finds that the least profitable connection fully covers variable costs. In addition, it indicates that it cannot be demonstrated that a capacity reduction or price increase would have led to lower losses over the company's total costs (Conseil de la Concurrence 2007, pp. 27 and 29).

Irrespective of the final decision, the case shows that at no point in its enquiry did the French competition authority doubt that Eurostar and BA operate in the same market. Clearly, the mere possibility of predatory practices would not be present if they were in unrelated markets.

3.7 Implications and conclusions

The Third Railway Package has the objective to induce and foster competition in international rail passenger transport. However, its implementation has been delayed, and several regulatory elements that have been added—like a public service operator levy—suggest that the rail sector will remain an industry under close scrutiny and protective measures from some national governments. Pro-competitive agencies like the German Monopolkommission view competition in the sector as an achievable objective but clearly state that entry faces major hurdles.

From a competition policy perspective, decisions by national or European competition authorities differentiate between product markets according to product characteristics from a consumer (here: traveler) perspective. Indeed, in several cases the European Commission has claimed that the substitutability of different transport modes depends especially on the needs of a particular group of travelers. In the European Night Services case, for example, two relevant service markets with differing preference sets have been defined: the market for the transport of business travelers and the market for the transport of leisure travelers. Similarly, in the Lufthansa/Austrian Airlines case the EC has found that

39 The market structure is clearly strongly asymmetric: Eurostar has a market share of 65-70%, Air France and British Airways each 10%, the rest being taken by Easy Jet and British Midland.

in addition to qualitative factors, total traveling time rather than distance is the decisive factor for consumers when it comes to the substitutability of alternative means of transport.

With respect to intermodality, in several recent cases high-speed rail transport has been considered a possible alternative to air travel as far as time-sensitive passengers are concerned. The means of transportation thus becomes a secondary characteristic in the evaluation of the relevant product market. By contrast, the European Commission's application of the 100 km/1 hour rule for the extension of the catchment area in the Aer Lingus-Ryanair case points to the fact that consumers are expected to evaluate the offers of competitors with respect to the total travel time "from home to home" as opposed to mere point-to-point service duration. This could be interpreted as a hint that especially within the segment of less time-sensitive travelers, secondary airports served by LCAs, even if they are not located in immediate proximity to a city, may still compete with railways typically serving city centers.

Both the substantial decrease of prices in air travel and the reduction of traveling time on railways have led to new constellations of competing modes of transport. However, competition authorities acknowledge that the distance range in which aviation and railways directly compete may be limited. For example, the Monopolkommission has a rather restrictive view of the competitive impact of aviation on trains outside the 400 km to 600 km range. Generally speaking, whether certain alternative modes of transport belong to the same product market can therefore only be properly assessed in any given case on a route-by-route basis. In this study, we will also follow the approach of analyzing individual O&Ds in terms of each O&D's particular contestability.

4.
The legal framework & existing co-operations

Any alliance established between incumbent rail operators in Europe is latently under the threat of being investigated in the framework of the EC's guidelines on Article 81 applicability to horizontal agreements. In this section, we first present a brief summary of the criteria under which an alliance is meant to be scrutinized when the EC suspects anti-competitive arrangements or practices. Then Railteam, as a recently founded and emerging co-operation, is presented in more detail.

4.1
The legal framework: Article 81

The EC's horizontal-agreement guidelines[40] balance an agreement's anti-competitive effects against its economic benefits. The commission acknowledges that companies need to respond to increasing competitive pressure and a changing market place driven by globalization, the speed of technological progress, and the generally more dynamic nature of markets. Faced with those challenges, cooperation can be a means to share risk, save costs, pool know-how, and launch innovation faster.[41]

The Commission suggests a test based on Article 81 that evaluates the following elements:

Market power

It is necessary to determine whether the parties are likely to maintain or increase market power through the co-operation. As a consequence of it, will

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[40] Commission Notice 2001/C 3/02, Guidelines on the applicability of Article 81 of the EC Treaty to horizontal cooperation agreements.

[41] Commission Notice 2001/C 3/02, p. 1.

they have the ability to cause negative market effects regarding prices, output, innovation, or the variety or quality of goods and services? For this part of the analysis, the commission calls for the relevant market(s) to be defined through use of the methodology of the commission's market definition notice.[42]

The EC further states that, beyond simple market share measures, other factors have to be considered as well, including stability of market shares over time, entry barriers and the likelihood of market entry, countervailing power of buyers or suppliers, and more generally the nature of the products (e.g. homogeneity, maturity).

Economic benefits
As indicated, the commission states that economic benefits induced by a horizontal agreement may outweigh the restrictive effects on competition. Indeed, a co-operation may enable firms to offer goods or services at lower prices and better quality or launch innovation more quickly. As these benefits relate to static or dynamic efficiencies, they can be referred to as "economic benefits". However, efficiency claims must be substantiated, and speculation or general statements on cost savings are not sufficient. In addition, the commission does not take into account cost savings that arise from output reduction, market sharing, or the mere exercise of market power.

Fair share for consumers
The economic benefits have to favor not only the parties to the agreement but also the consumers. The commission further comments that, in general, the transmission of benefits to the consumers will depend on the intensity of competition within the relevant market. Competitive pressures will normally ensure that cost-savings are passed on by way of lower prices or that companies have an incentive to bring new products to the market as quickly as possible. The commission concludes that if sufficient competition effectively constraining the parties to the agreement is maintained on the market, the competitive process will normally ensure that consumers receive a fair share of the economic benefits.

Indispensability
Restrictions on competition, i.e. the horizontal agreement, must be necessary to achieve the economic benefits.[43] In this respect the guidelines state that if there are less restrictive means to achieve similar benefits, the claimed efficiencies cannot be used to justify the horizontal agreement. Whether or not individual restrictions are necessary depends chiefly on market circumstances and the duration of the agreement.

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[42] For further details we refer to the introduction of the preceding section on relevant EU cases.

[43] Commission Notice 2001/C 3/02, p. 5.

No elimination of competition

The last criterion reiterates that where an undertaking is dominant or becoming so as a consequence of a horizontal agreement, an agreement that produces anti-competitive effects in the sense of Article 81 cannot in principle be exempted.

4.2 Existing and past co-operations

Co-operations between European rail operators have existed for several decades. In Western Europe, they were mainly restricted to the operation of EuroCity trains, the multinational equivalent of the InterCity train, which can be considered—to some extent—the predecessor of current high-speed technology vehicles. EuroCity trains were first introduced in 1987, but they often followed the routes of luxury trains initiated as early as the 19th century.

The first move to create a proper European rail system for large-scale, long-distance passenger transport was the Trans-Europe Express (TEE), which was established in 1957. The initial idea of serving only international routes was abandoned in 1965, though, with the introduction of the French “le Mistral” and the German “Blauer Enzian”. The network included the railway companies of West Germany (DB), France (SNCF), Switzerland (SBB-CFF-FFS), Italy (FS) and the Netherlands (NS). The Belgian railway company (NMBS/SNCB) joined in 1964, Luxembourg (CFL) and Spain (RENFE) later, while Denmark (DSB) and Austria (ÖBB) were no official members but had TEE services circulating on their territory.

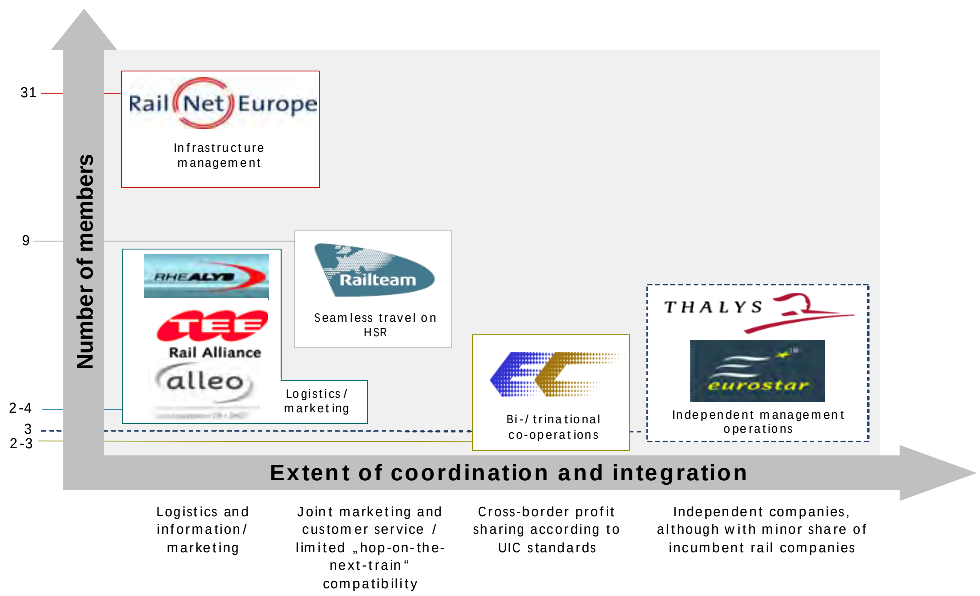
In the beginning, the system was run with diesel locomotives, which was related to problems of interoperability and—in parts—not electrified border crossings. The rolling stock was intended to provide highest quality standards to the travelers, i.e. only first class coaches with catering on all routes. In almost all cases the rolling stock was especially built for TEE services, but was downgraded later due to rising travelling standards.

Since the 1970s, an increasing number of TEE trains got replaced by more modern trains that provided the same level of service but had passenger compartments for the second class, too. In 1979, DB completely restructured the network with the coming of the new national IC services. By 1984, most TEE services were abolished, leaving only some national services in (mostly) Italy and France and very few international routes.

In 1987 a new brand was introduced, the EuroCity, designed specifically for international services, providing both first and second class. During the pre-Schengen era, passport checks were conducted on EC trains while in motion, rather than while parked at a station or requiring the passengers to disembark, as was sometimes the case for non EC trains. A few trains required pre-reservation and in some countries a supplemental charge. Although EuroCity trains have now become a less convenient means of passenger rail transport compared high-speed rail services like ICE and Thalys, the network is still operated on bilateral or trilateral level. The EC agreements typically include cross-border profit sharing arrangements according to UIC standards, and have only recently become more a topic of individual negotiations between rail incumbents.

Apart from TEEs and EuroCity trains, a number of other co-operations have emerged over the last years. Some of them are more related to infrastructure services; others have a focus on marketing instruments and joint services like ticketing. The following figure shows an overview of important present-day co-operations.

Figure 2: Existing co-operations in European railways



Source: ESMT CA

RailNetEurope is an organization bringing together 33 rail infrastructure managers from across Europe whose main objective is—according to their website—to enable easy and fast access to European railway infrastructure and increase the quality and efficiency of cross-border rail traffic.

The TEE Rail Alliance was founded in 2000 as a joint venture between the incumbent rail companies of Germany, Austria and Switzerland in order to achieve a better scheduling between domestic and cross-border trains as well as to offer high-quality services to customers. One of the benefits for passengers is that national customer loyalty schemes like the BahnCard or the ÖsterreichCard are accepted abroad and can be used for claiming reduction on the ticket price. In addition, some loyalty products like the "bahn.comfort" card can be used to enter frequent traveller lounges in other countries.[44] Rhealys, on the other hand, was a company founded in 2000 by the rail operators in France (SNCF), Germany (DB AG), Switzerland (SBB) and Luxemburg (CFL) in order to conduct market studies and to prepare the high speed railway from Paris to Luxemburg, Southern Germany, Basel and Zurich.[45] Alleo is a joint venture between DB and SNCF to coordinate the promotion and marketing of the LGV Est Européenne from Paris to Frankfurt and Stuttgart. It was founded in 2007 and took over several tasks that were formerly assigned to Rhealys.

Apart from the above-mentioned joint ventures, SNCF runs joint operations of high-speed services with minority shares of Swiss SBB called "TGV Lyria," in which SBB owns some of the rolling stock. TGV Lyria operates up to 17 round trips per day between France and Switzerland.[46] Similarly, Elipsos is a joint venture between the French national railroad, SNCF, and the Spanish national railroad, RENFE. It was created in 2001 to manage the night-time Trenhotel railway services between Spain and France, Spain and Switzerland, and Spain and Italy.[47]

While the previously mentioned co-operations are mainly focused to improve the efforts of better co-ordination and marketing between incumbent rail companies, Thalys and Eurostar are independent companies; their incumbent rail operators may hold shares but do not interfere with day-to-day operations, management, and strategy.

Figure 2 shows that under current co-operations coordination exists either with a large amount of participants on a very basic level of coordination concerning the infrastructure, as with RailNetEurope, or with a low number of participants but high levels of integration, as with the operationally independent Thalys and Eurostar companies.

In any case, the logistics of optimizing train schedules in meshed networks induces a degree of coordination. Under a new competitive arrangement of the sector after 2010, these forms of coordination would have to proceed, irrespective of the existence of further agreements. In its current dimension, Railteam is the most encompassing coordinative attempt among European railways operators. A closer analysis of the arrangement will assess its character in respect to its impact on competition among the Railteam partners.

[44] See also http://www.bahn.de/p/view/preise/international/tee_alliance.shtml.

[45] See also the Rhealys website under http://www.rhealys.com/ as well as a brief description of the cooperation in http://ec.europa.eu/transport/intermodality/passenger/doc/report_2_en.pdf, p. 16.

[46] See also http://www.railteam.co.uk/Carrier/TGV-Lyria.

[47] See also the company website http://www.elipsos.com/htm/default.htm?lang=3.

Railteam

Railteam is a co-operation between Europe's leading high-speed rail operators, currently DB (Germany), SNCF (France), Eurostar (UK, France, and Belgium), NS Hispeed (Netherlands), ÖBB (Austria), SBB (Switzerland), and SNCB (Belgium), together with two of their high-speed subsidiaries, Thalys and Lyria; the possibility exists for more train operators to join in the future. Railteam acts as a "quality alliance of European high-speed operators"[48] with the aim of the "creation of a client based international high speed rail network in Europe for international travelers moving more people from air and road to rail." Deutsche Bahn emphasizes that Railteam "will increase connectivity, service and easy access due to better operation amongst operators. It will not be a new railway undertaking nor an international grouping." (ibid.)

Once technical adaptations are finalized, passengers will be able to book any Railteam journey through any partner point of sale at the cheapest rate, including tickets for multi-leg journeys. Further into the future, it is envisaged that customers will be able to exchange, modify, or cancel their tickets by contacting any of the Railteam partners, whichever country they are traveling in. The IT platform will be open to all rail operators at the same conditions, irrespective of Railteam membership (a business concept similar to Amadeus in air travel).

In addition, Railteam will offer specific services across the whole network to top-tier frequent travelers registered with one of the Railteam companies, including access to both business lounges and discounted car rental in many major European cities. Further offers are planned, in particular the extension of the existing "earn and spend" points-program across the whole network.

In respect to the scheduling of operations, a more intense co-operation is envisaged (e.g. no substantial delays in Brussels while changing from ICE to Eurostar on the way to London), which is—due to the network character of the rail tracks—indispensable for a smooth functioning of the entire system. Easier connections and better connectivity and improved coordination of departure and arrival time are the expected results of the endeavor.

In many respects, the focus on improved travel quality corresponds to the requirements put forward by the European Commission, especially the TAP-TSI requirement (Telematic Application for Passengers), as laid down in the Interoperability Directive 2001/16 and the presumably forthcoming Passenger Rights Regulation. Furthermore, the Railteam services are concordant with the priorities of the Trans-European Transport Networks ("TEN-T") regarding high speed lines. According to DB, "70% of connections provided on the TEN network in 2010 within Railteam comprise a change of operator. Here in particular, Railteam brings added value."

[48] Internal communication by Deutsche Bahn.

An Intraplan study, released in 2006, predicts around 10 million additional passengers within the Railteam network, 1 million of this increase being due to the existence of Railteam. According to Intraplan, the effect of Railteam is expected to mainly be apparent on routes with a connection (with the same operator or a change of operator), "as it increases attractiveness due to the perception as a seamless journey."[49] While the Railteam co-operation has to be considered unambiguously pro-competitive, given its limited scope and the low level of liberalization of the present relevant long-distance European passenger transport segment, the more general question arises as to how far post-liberalization co-operations between rail companies may evolve, the extent of their scope and intensity, and whether such agreements will be supportive (or even required) for effective competition to arise in the long-distance passenger transport segment.

4.3 Implications and conclusions

Co-operations in the European passenger rail system have existed since the 1950s, when the Trans-Europe Express network was established, and have since then continued with the EuroCity system and a range of bilateral and trilateral co-operations that mainly target marketing and interoperability. Railteam therefore stands in a long tradition of providing integrated European rail services to passengers. However, in the perspective of liberalization of the sector, it also represents an alliance between incumbent rail operators in Europe and is thus potentially subject to investigation under the EC's guidelines on Article 81 applicability to horizontal agreements. It bundles the activities of incumbent rail operators in the "software" component of transport services, though, e.g. marketing efforts, a joint IT platform, "hop-on-the-next-train" options if trains of competitors are delayed, and so forth, thus enhancing passenger comfort and service quality without interfering in operators' independent determination of the existence, extent, and frequency of individual train services. The "software" focus of Railteam even coincides with the commission's quest for further standardization of services across Europe.

[49] Internal communication by Deutsche Bahn.

5. Analysis of competition for long-distance passenger transport

The objective of this analysis is to assess the impact of the commission's Third Railway Package on the evolution of the European long-distance passenger rail sector after 2010. How will the structure of the sector change? Will there be new entry, and how will incumbent operators react to the challenge of liberalization? What will be the impact of the rise of air carriers on rail traffic, and vice versa—the impact of a European-wide network of high-speed connections on flight patterns? In the following we outline the methodology applied in order to answer these questions.

5.1 Overall methodology

Given the competition authorities' focus on origin and destination as the relevant unit of analysis, we follow a similar approach by examining individual routes rather than the whole rail network.

The empirical analysis we carry out on an O&D level has two dimensions. First, we conduct a panel data analysis to evaluate the impact of intermodal competition on relevant rail routes ("panel data analysis"). In particular we analyze the impact of entry by low cost airlines into a specific O&D on DB's prices, output, and revenue figures. Second, the likelihood of entry into individual O&Ds is assessed for various entry scenarios based on a set of indicators including the level of intermodal competition as previously measured ("scenario analysis"). This allows us to identify the future counterfactual situation under the assumption of the Third Railway Package's implementation and to analyze the impact of alliances in accordance with Art. 81.

Before we provide an analysis along those lines, the following sub-section provides an overview of the underlying data set and describes the competitive situation within the analyzed O&D universe.

5.2 The data set and competitive situation within the O&D universe

Our assessment is based on a comprehensive and unique data set of 207 national and international O&Ds where either the origin or destination lies within Germany ("the O&D universe"). Seventy-seven of the routes are national routes and 130 are international routes. The international routes cover O&Ds from Germany to Denmark, the Netherlands, Belgium, France, Austria, and Switzerland, while the remaining O&D have domestic (i.e. German) origins as well as destinations. The data set covers monthly price data over the January 2006–October 2007 period as well as passenger numbers, revenues, and passenger kilometers (pkm) and was constructed on the basis of figures provided by Deutsche Bahn. DB also supplied data pertaining to railway cost and quality indicators. These figures were supplemented by both publicly and manually collected data on a wide range of more general variables taking in LCA competition, railway demand shifters, and airline supply. This data is described in greater detail in the panel data analysis.

The O&Ds analyzed in this assessment yield approximate overall annual revenues of around €402 million for the O&D universe, which corresponds to around 12% of a total of €3,265 million revenues according to the financial statements of DB long-distance passenger transport in the year 2007.

As we see in figure 3, the O&Ds covered by the analysis are differently affected by the level of existing (strong) airline competition. Weak or strong airline competition is determined by estimates from the Intraplan Survey 2005: in a preliminary categorization, which primarily serves to examine the representative character of the dataset, we classify weak and strong competition by the ratio between flight passengers and rail passengers. All plane/train ratios above one are considered strong; below one they are considered weak.[50] Roughly half of all

[50] Note however that this distinction is only for illustrative purposes. In order for a strong competitive constraint to exist, it is sufficient if a small number of passengers can choose between air and rail travel.

O&Ds are affected by strong airline competition. The following figure shows how the routes can be classified in matrix form.

Figure 3: Selection of O&Ds according to four clusters

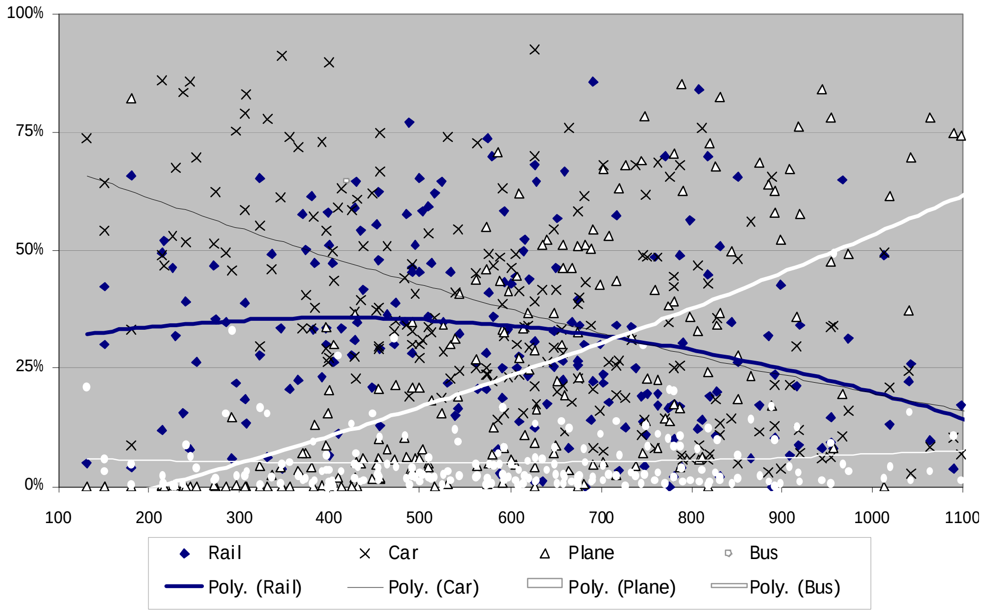
	Strong airline competition*		Weak arline competition	
International route	I		II	
	Number of observations	*77*	Number of observations	*53*
	Ratio Flight to Train (Simple average)	*11,03*	Ratio Flight to Train (Simple average)	*0,16*
	Number of LCA entries	*11*	Number of LCA entries	*6*
Domestic route	III		IV	
	Number of observations	*29*	Number of observations	*48*
	Ratio Flight to Train (Simple average)	*0,96*	Ratio Flight to Train (Simple average)	*0,19*
	Number of LCA entries	*1*	Number of LCA entries	*15*

Annotation: *Definition 'strong airline competition': ratio flight to train above 1 or LCA entry in observation period

Described more generally, rail transportation competes with air transportation on the one hand and car and bus transportation on the other hand. One of the most important criteria differentiating the various transportation modes and delineating their relevance from a consumer perspective is not necessarily distance, but traveling time.

Figure 4 shows the relevance of various transportation modes for the O&D universe. The horizontal axis depicts the distance, the vertical axis the intermodal split. Regarding competition by cars and trains, the ratio decreases up to distances of 200 to 300 km and remains stable for longer distances. Busses hold a relatively stable but small modal share across all distances.

Figure 4: Modal shares in the O&D universe



Source: Intraplan data for 2005; trend line ESMT CA; based on passenger figures.

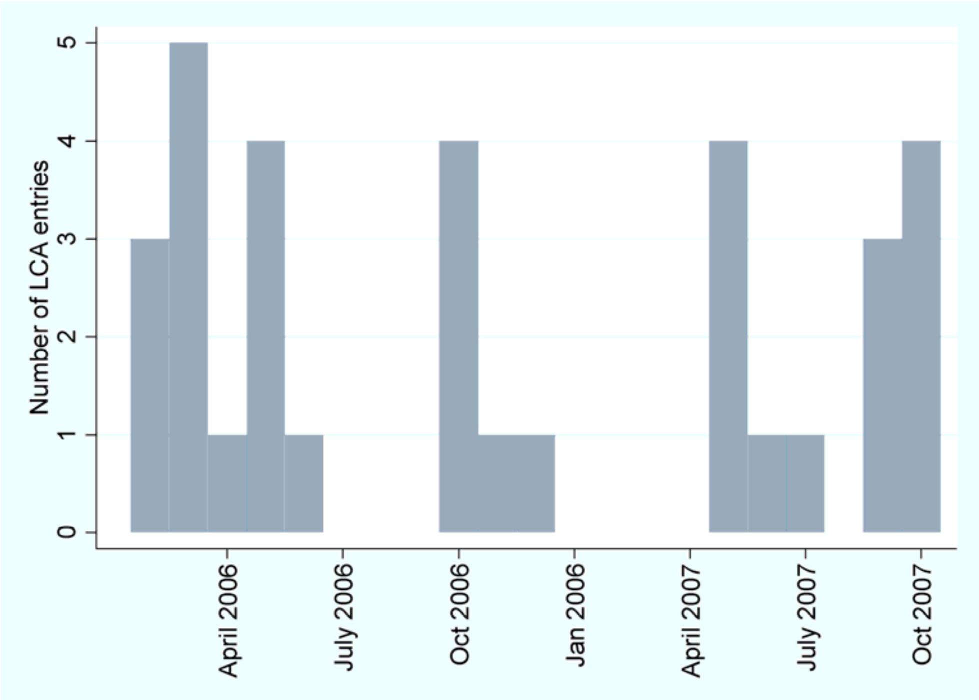
Regarding airlines, within the O&D universe we observe a positive modal share for distances above 300 km that passes the 10% threshold for distances above 450 km. This is in line with a general perception that the time advantage of air transportation gets lost for lower distances.[51]

For larger distances the time advantage of traveling by plane becomes so large that—at least for business travel—the train is no longer an effective competitor. Accordingly our data set shows that for distances above 800 km, the modal split of rail transportation falls below 30%.

Figure 5 shows the amount of LCA entries, indicating substantial existing competition with LCAs. We observe that around 35% of all O&Ds in our sample are covered by LCA entries during the January 2006-October 2007 period. For a further 12% of O&Ds, LCAs were already active before January 2006.

[51] See for instance Monopolkommission 2006, 36pp. As indicated above the Monopolkommission considers air and rail as only remaining in strong competition for distances between 400 and 600 km.

Figure 5: LCA entry over time in the O&D universe, January 2006 - October 2007



Source: authors' calculations based on inquiry from various LCAs; press releases of LCAs and airports.

When it comes to intramodal competition in German long-distance rail traffic, only few examples exist, with the Cologne-Brussels link included in our data set (see below). In addition, several lower-speed services operate on routes in eastern Germany, but they are not covered by the data:

- High-speed rail segment:
  - Thalys operates O&D between Cologne and Brussels.
- Long-distance rail segment:
  - Vogtlandbahn GmbH (subsidiary of Arriva Deutschland GmbH) operates on the Munich-Prague and Plauen-Berlin O&Ds.
  - Veolia Verkehr GmbH (formerly Connex) operates on the Leipzig to Rostock/Warnemünde via Berlin O&D.
  - In 2003 alone, Connex operated between Cologne and Berlin.

Due to the limited amount of actual competition, we will therefore base the following assessment on the virtual case of potential future entry rather than the rare existing examples of intramodal competition, thereby providing a comprehensive overview of barriers to entry in European long-distance rail passenger transport on more than 200 O&Ds. However, in a first step we will assess the impact of intermodal competition in a panel data analysis.

5.3 Panel data analysis

While *intra*modal competition in the German rail passenger transport sector is already possible but not yet taking place on a large scale, Deutsche Bahn faces the present reality of *inter*modal competition from airlines in the long-haul passenger sector. This situation was largely triggered by the 1997 EU deregulation of the airline market, which stimulated a large influx of LCAs and dramatically reduced prices for long-distance air travel offered by both LCAs and incumbent national carriers in response to LCA entry.

In this section, we conduct a panel data analysis examining the effect of (intermodal) competition from airlines on DB's passenger rail services. The main questions we will address are:

- To what extent do airlines and DB compete in the long-distance passenger transport market?
- What is the effect of competition from airlines on DB's long-distance passenger rail service?

The strength of this analysis lies in four main factors:

i. We have a uniquely large and representative sample. This assures that our results are not merely artifacts but are representatives of more general patterns.

ii. We employ panel data. This permits us to control for unobserved heterogeneity, which may otherwise lead to very imprecise or biased estimates of competitive effects.

iii. We have built a dataset allowing us to control for a wide variety of factors that may have a bearing on our outcomes of interest. This assures that our results are reasonably robust.

iv. We attempt to deal with the problem that LCA entry may be endogenously determined by DB prices, leading to biased estimates.

Empirical model

Baseline model

The main equation we will be estimating is the following:

$$y_{it} = \delta LCA_{it} + \gamma \mathbf{z}_{it} + \lambda_t + \varepsilon_{it} \qquad (1)$$

where the subscript *i* refers to a given O&D and *t* refers to month *t*. Our dependent variable is y_{it}. It refers, in four alternative specifications estimated separately for first class and second class, to the natural logarithm of passenger numbers (lpax), the average ticket price (lavprice), revenue (lrev) and passenger-kilometers (lpkm)—in other words, Deutsche Bahn outcomes.

Our main explanatory variable of interest is LCA_{it}, which is a dummy variable equal to 1 in the period of entry *and* subsequent operation for those routes experiencing LCA entry over our observation period. δ therefore captures the long-term effects of LCA entry on DB outcomes.[52] Our main interest will be in examining the sign and statistical significance of this coefficient, as it captures whether and to what extent DB is subject to competitive pressures from LCAs.

Competitive pressure from LCAs may be reflected in all four of the above-mentioned outcome variables. In general, the effect of competition on demand and passenger kilometers is ambiguous. If DB prices do not respond to LCA entry, we would expect competitive pressures from LCAs to be manifested in the form of a fall in overall passenger numbers, as customers switch from rail to air transport, with a commensurate fall in passenger kilometers. If DB prices increase, we would expect a fall in passenger numbers and passenger kilometers. If DB prices decrease, this should lead to an increase in the demand for rail transport. However, this reduction in prices may not be sufficient to counter the attraction LCAs hold for passengers.

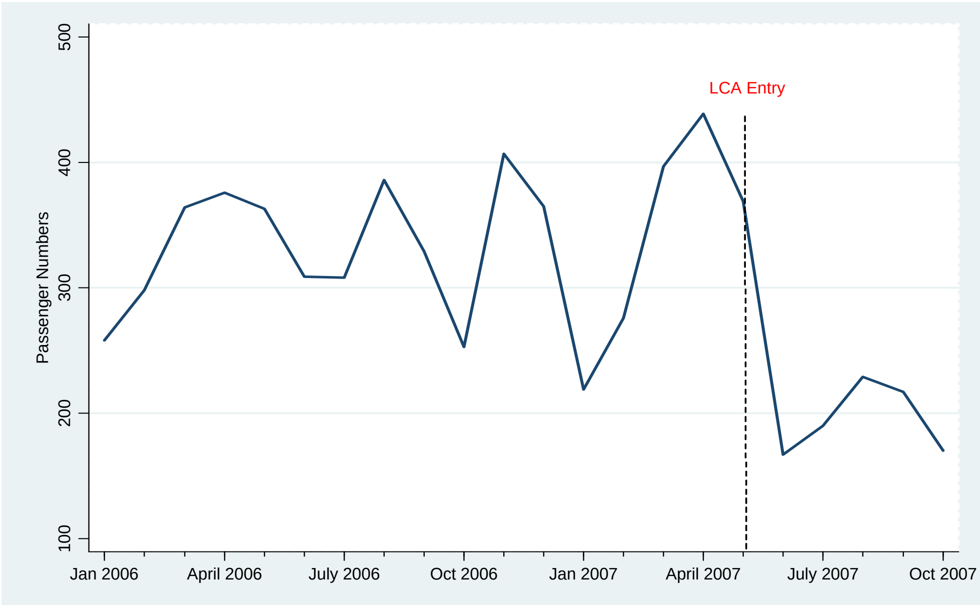
Given that DB does not have a great deal of short-term leverage on quality variables, it is reasonable to expect that it would respond to LCA entry by lowering average prices (for example, through special offers or increasing the proportion of low-priced seats). Evidence of competitive pressure exerted by LCAs on DB would then be manifest in an estimated value $\delta < 0$.

We expect the long term effects of LCA entry on revenues to be negative (or at least non-positive). The logic is as follows. As we just argued, DB does not have short-term flexibility in cost savings or quality changes. This means that the main instrument it has at its disposal to influence profitability is prices. If any change in its pricing policy in response to LCA entry results in increased revenues, this would suggest that DB's pricing policy was not optimal (i.e. profit-maximizing) to begin with, and this seems unreasonable.

[52] Allowing for additional shorter-term effects does not result in any qualitative changes in the results.

The following graph illustrates the structure of our data as well as the relationship between LCA entry and second class passenger numbers. The data below covers one O&D, so *i*, in this case, is the relevant O&D. We observe the monthly number of passengers traveling from origin to destination between January 2007 and October 2008. The data presented below thus represents twenty-two observations in our dataset. In this example, the low-cost airline entered in May 2007 and operated on this O&D for the entire observation period. This means that for this particular observation, LCA_{it} would equal 0 before May 2007 and 1 thereafter.

Figure 6: LCA entry and second class passenger numbers on an exemplary O&D



Source: DB and LCA data. Data presented here represents 3-month averages.

In this example, the low-cost airline's entry coincided with a large drop in second class DB passenger numbers. And this decline appears to be persistent: the average number of passengers after entry is significantly lower than that prior to entry. The solidity of our analysis lies in the fact that our conclusions are not based on one O&D comprising 22 observations but on 207 O&Ds comprising over 4000 observations. (In this particular case, however, it turns out that what is actually exemplified is a general pattern in our data: second class passenger numbers drop following the entry of an LCA.)

Of course, LCA entry can be one of many reasons why this lower average effect is observed. To account for other factors, we include $\mathbf{z}_{it}$ on the right hand of equation (1). It is a vector of (potentially time-varying) characteristics of route *i*.

It controls for potential railway demand and supply shifters—factors other than LCA entry that may be responsible for changes in our DB outcomes of interest. When these variables are continuous (as opposed to discrete) they are presented in natural logarithms. Since our dependent variables are also in logarithms, this permits us to interpret their coefficient estimates as the percentage increase in y corresponding to a 1% increase in $\mathbf{z}$.

λ_t captures a potentially time-varying intercept, which effectively detrends our data. ε_{it} is the error term.

Endogeneity concerns

The major challenge in panel data estimation of this sort is the presence of unobserved O&D effects that may have a bearing on the outcome but are not observed by the researcher. The extent to which any time-invariant unobserved effects impact our estimates depends on whether or not they are correlated with our explanatory variables. When they are *not* correlated but the error term is serially correlated, pooled ordinary least squares (OLS) applied to equation (1) will result in biased standard errors (i.e. we are not sure whether the statistically significant results we observe are truly significant). When the unobserved effect *is* correlated with any of our explanatory variables, our estimates of δ will be biased.

In our case, tests suggest that the error term *is* serially correlated. In such positive cases, random effects (RE) estimation is preferred to pooled ordinary least square regression (OLS). Since many of our explanatory variables do not vary substantially overtime, fixed effects (FE) can result in imprecise estimates. RE are preferred to FE when the unobserved effect is uncorrelated with the explanatory variables. With large samples such as ours, this tends to be the case, and with our data a Hausman specification test suggests that RE is the more appropriate estimation technique.

Consequently our main results primarily describe the RE estimates. Pooled OLS and FE estimates are presented in the panel data appendix by way of comparison.

Our specification tests give us reason to believe that endogeneity in the form of correlation between the time-invariant unobserved effect and our explanatory variables is not a major source of concern. Still, we may be concerned that when and where an LCA chooses to enter may be a strategic decision. In particular, it is possible that LCAs are choosing to enter precisely those O&Ds where it is easy to compete with DB—those on which DB has relatively high prices.[53] This means that when our dependent variable is DB ticket prices, our estimate δ—the effect of LCA entry on ticket prices—suffers from selection bias. The true effect of LCA

[53] We do not address the possibility of endogeneity of this form in the case of passenger numbers, revenues, or pkm. Although we cannot rule it out, making an entry decision based on these variables seems unlikely because (a) passenger numbers are an outcome of DB's competitive strategy whereas prices can be a strategic choice of DB; (b) passenger numbers are likely to be noisier measures than prices; and (c) such passenger data is not publicly available at the O&D level whereas price data are.

entry on DB prices is likely to be *lower* than our RE estimates suggest, since LCA entry is likely to be positively correlated with DB ticket prices.

The standard way of dealing with problems of this nature is through instrumental variable (IV) methods. The basic idea is to find an exogenous variable which has a bearing on the LCA entry decision but is not correlated with error process in equation (1).

Finding an appropriate instrument in this particular context is not trivial since we are faced with a dual endogeneity problem in the sense that LCAs face a strategic choice of not only *where* but also *when* to enter. This means that we ideally require an instrument that varies over time and satisfies the two assumptions required in employing IV methods: (1) the excluded instruments are distributed independently of the error process and (2) they are sufficiently correlated with LCA entry.

Two (excluded) instruments capturing network effects perform well in the case of the DB price model (i.e. where prices are the dependent variable). The first is the number of LCAs operating into or out of the origin, to or from a city other than the destination. The second is the number of LCAs operating into or out of the destination, to or from a city other than the origin corresponding to O&D *i* at time *t*.[54] The intuition is that such O&Ds are likely to be seen as viable candidates for LCA entry to the extent that ongoing LCA activities on the end points corresponding to these O&Ds have characteristics that have already proved conducive to LCA operation. At the same time the LCA operation *between an O&D's end points and other destinations* is unlikely to be influenced by DB prices *between the cities corresponding to that O&D*.

There are a variety of viable estimation methods. We report the most precise of these estimates in our results section. Other IV estimates, as well as a more rigorous description of the endogeneity issues and ways in which we confront them, are described in the panel data appendix.

Data

Our data comprises a balanced panel pertaining to 207 O&Ds observed over a period of 22 months from January 2006 to October 2007. This amounts to 4554 O&D-month observations. In this sample, we observed 33 entries of 9 airlines from January 2006 until October 2007 (appendix A2.3, table 8).[55] This amounts to 12.3% and 22.1% of the total international and domestic O&Ds having experienced LCA entry over the sample period. The distribution of LCA entry time distribution is presented in figure 5.

Table 3 presents summary statistics for the variables used in our analysis. Details pertaining to data sources and variable construction are presented in the panel data appendix.

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54 A variety of other instruments, including this variable disaggregated by airlines as well as airline delays, proved ineffectual and we were unable to find any effective instrument for lpkm, lpax or lrev.

55 There are no overlapping LCAs entries; thus each entry represents a single route.

Both passenger numbers and ticket prices were provided by DB, disaggregated by first and second class, representing the fact that these are two separate markets. Revenues were calculated as the product of the corresponding passenger numbers and average prices. Passenger kilometers were only provided by DB for domestic O&Ds; those for international O&Ds were constructed by multiplying passenger numbers by the length of the train path.

For our complete sample, i.e. all O&Ds over the entire sample period, $\mathbf{z}_{it}$ includes 10 variables capturing 6 different effects as follows: (1) Whether or not an LCA was already present (and operating) on O&D in 2006; this measures the extent of competitive pressure exerted by LCAs (as opposed to incremental). (2) Whether the O&D pair is domestic, i.e. both the origin and the destination lie within Germany; this variable mainly accounts for the possibility that DB may have more pricing flexibility on domestic than on international routes. (3) Populations in the catchment area of the origin and the destination; those are likely to be positively correlated with aggregate demand for long-haul transport in general. (4) Prices of coal, kerosene, and oil; while coal prices may affect electricity generation costs relevant to high-speed rail transport, kerosene and oil prices are likely to have a bearing on costs faced by airlines, as well as on passenger demand for automobile travel. (5) Driving duration from city center to city center; this allows for the empirical regularity of the choice of transport mode being influenced by travel times, with cars being preferable at the lower end and planes at the upper end. (6) Whether or not the O&D is serviced by an ICE connection; this captures rail quality to the extent that ICEs are typically faster, more likely to be direct, and have more services offerings than other train types.

We present results for our complete sample (as well as a more limited sample for which we have additional controls). The limited sample comprises 84 O&Ds, of which 22 are international. The additional controls include (1) general airline supply and quality controls comprising the number of available airline seats and flights as well as air travel duration, and plane delays and (2) rail costs and quality, as measured by train path prices for both the fastest and the lowest-cost path, and trail travel duration. Table 3 provides descriptive statistics for all available observations.

Table 3: Descriptive statistics of the complete sample (January 2006-October 2007)[56]

Variable	Variable description	Obs	Mean	Std. Dev.	Min	Max
DEPENDENT VARIABLES						
lavprice2	(Log) average second class ticket price	4415	4.03	.45	0	6.02
lpax2	(Log) number of second class train passengers	4421	5.79	2.48	0	11.72
lrev2	(Log) second class revenue	4415	9.77	2.29	0	15.04
lpkm2	(Log) second class passenger – kms of train traffic	3527	12.64	2.11	6.37	17.37
lavprice1	(Log) average first class ticket price	3886	4.52	.47	2.88	6.62
lpax1	(Log) number of first class train passengers	3916	4.24	2.38	.00	9.99
lrev1	(Log) first class revenue	3886	8.67	2.18	2.20	13.86
lpkm1	(Log) first class passenger – kms of train traffic	3325	10.76	2.31	.00	15.65
LCA COMPETITION						
LCA	LCA=1 if LCA entered and operated during sample period, else LCA=0	4554	.09	.28	0	1
presence06	presence06=1 if LCA was in operation before and during sample period, else presence06=0	4554	.12	.33	0	1
domestic	domestic=1 if both origin and destination located within Germany, else domestic=0	4554	.63	.48	0	1
RAIL DEMAND SHIFTERS						
lorig_pop	(Log) population in the origin catchment's area	4554	8.21	.80	6.05	9.33
ldest_pop	(Log) population in the destination catchment's area	4554	8.18	.71	6.05	9.36
ldistance	(Log) road distance	4554	6.27	.44	4.54	7.02
lkerosene	(Log) price for jet kerosene	4554	0.06	.00	0.05	.07
loil	(Log) price for crude oil	4554	.05	.00	.04	.05

56 For a complete table with reference to the sources, please see appendix A2.3, table 7

Variable	Variable description	Obs	Mean	Std. Dev.	Min	Max
AIRLINE SUPPLY & QUALITY						
lseats	(Log) number of seat, e.g. capacity	3328	4.24	1.55	.00	7.05
lflights	(Log) number of flights	3328	.81	.51	.01	2.20
lagldelay	(Log) lagged flight delay on route	3192	3.39	.16	3.05	3.93
lair_dur	(Log) flight duration (min)	3066	4.78	.59	3.71	5.87
AUTOMOBILE QUALITY						
lauto_dur	(Log) duration by auto (min)	4554	5.71	.50	4.11	8.74
RAILWAY COSTS AND QUALITY						
ltrain_dur	(Log) duration by train (min)	4510	5.80	.45	4.17	6.77
lrailfast_price	(Log) cost for the fastest train path (€)	3534	1.30	.48	.11	5.71
lraillow_price	(Log) lowest cost of train path (€)	3534	1.08	.30	.11	1.82
lcoal	(Log) price for plant coal	4554	.06	.00	.06	.08
ICE	ICE=1 for ICE train type, else ICE=0	4554	.50	.50	0	1
INSTRUMENTS						
lairlines_orig	(Log) number of operating airlines in the origin hub	4554	1.41	.46	.00	2.20
lairlines_dest	(Log) number of operating airlines in the destination hub	4554	1.40	.68	.00	2.20

Note: The logarithms are, without loss of generality, expressed in log(x+1) in order to avoid negative values.

Table 4 examines how our limited sample with additional controls compares to the sample as a whole.[57] Most of our outcome variables of interest are not significantly different in our complete sample relative to the restricted sample for which additional controls are available (only first class prices are significantly higher in the latter group.) However, the samples are substantially different on almost all other dimensions. In particular, O&Ds in the limited sample face greater competitive pressure from airlines: they are significantly more likely to have faced LCA presence in 2006, and have a larger number of flights and airline seats being offered, and they are characterized by fewer delays and shorter flight travel time. They are not significantly longer in distance, but (perhaps because they are more likely to be serviced by ICEs) they take significantly less time to travel by train although they entail longer car travel times. They are also

[57] Note that the "complete sample" may in this case not reflect all observations: the mean reflects the mean for all observations for which this control variable is available.

characterized by significantly higher rail path costs. In sum, the sample for which we have a larger additional set of controls tend to characterize large domestic routes on which DB offers high quality services and where airlines are already operating multiple services at the beginning of our sample period.

Table 4: Descriptive statistics of sample (additional controls)

		Additional controls	Complete sample	
Variable	**Variable description**	**Mean**	**Mean**	**Difference**
lpax2	(Log) number of second class train passengers	7.106	5.789	1.317
lavprice2	(Log) average second class ticket price	4.003	4.036	-0,033
lrev2	(Log) second class revenue	11.084	9.775	1.309
lpkm2	(Log) second class passenger – kms of train traffic	13.429	12.643	0.786
lpax1	(Log) number of first class train passengers	5.072	4.240	0.832
lavprice1	(Log) average first class ticket price	4.513	4.522	-0.009***
lrev1	(Log) first class revenue	9.528	8.679	0.849
lpkm1	(Log) first class passenger – kms of train traffic	11.328	10.760	0.568
Presence06	presence06=1 if LCA was in operation before and during sample period, else presence06=0	0.192	0.121	0.071***
domestic	domestic=1 if both origin and destination located within Germany, else domestic=0	0.763	0.633	0.130***
lorig_pop	(Log) population in the origin catchment's area	8.350	8.214	0.135***
ldest_pop	(Log) population in the destination catchment's area	8.239	8.176	0.063***
ldistance	(Log) road distance	6.273	6.266	0.007
lcoal	(Log) price for plant coal	0.062	0.062	0.000
lkerosene	(Log) price for jet kerosene	0.062	0.062	0.000

		Additional controls	Complete sample	
Variable	**Variable description**	**Mean**	**Mean**	**Difference**
loil	(Log) price for crude oil	0.047	0.047	0.000
ICE	ICE=1 for ICE train type, else ICE=0	0.649	0.502	0.146***
lsit	(Log) number of seat, e.g. capacity	4.857	4.241	0.616***
lflight	(Log) number of flights	1.033	0.809	0.224***
Lagldelay	(Log) lagged flight delay on route	3.350	3.392	-0.042***
lauto_dur	(Log) duration by auto (min)	5.736	5.711	0.025***
ltrain_dur	(Log) duration by train (min)	5.733	5.797	-0.064***
lair_dur	(Log) flight duration (min)	4.543	4.783	-0.241***
lrailfast_price	(Log) cost for the fastest train path (€)	1.385	1.296	0.089***
lraillow_price	(Log) lowest cost of train path (€)	1.114	1.082	0.032***

*p<0.10 **p<0.05 ***p<0.01 reflects the results of a t-test for the difference in means.

Results

Table 5 presents our main results. It summarizes the long-term effect of LCA entry. Each column represents a different regression equation whose dependent variable, y_{it}, is mentioned in the column heading. Results are estimated separately for second class and first class in, respectively, the top and bottom halves of the table. The percentages, highlighted in blue, reflect the long-term effect of LCA entry. These numbers explain how much the dependent variable changed in O&Ds into which an LCA entered and operated between January 2006 and October 2007, relative to those O&Ds into which an LCA did not enter over this sample period.

These percentages represent marginal effects associated with the estimates for δ (the coefficient of LCA_{it}) presented in the regression tables provided in the appendix. More specifically, the percentages presented in columns 1-4 correspond to the full-sample RE point estimates presented in the first row and third column of the appendix tables; the percentages presented in column 5 and 10 correspond to column 8 and 9 of the first row in tables 11 and 15 in the appendix A2.4, respectively.[58]

[58] The observant reader will notice that the numbers in this table do not perfectly match the point estimates presented in the appendix. The reason for this is that a small correction has to be made when interpreting the coefficient of a dummy right-hand-side variable with a log dependent variable. In particular if a% is the number presented in the tables, the following relationship holds: *a%=exp(b)-1*, where b is the regression-based point estimate.

Columns 1-5 present results for the complete sample and include the controls presence06, domestic, lcoal, lkerosene, loil, ldistance (except when lpkm is the dependent variable), lorig_pop, ldest_pop, lauto_dur, and ICE. Estimates for the model with additional controls in columns 6-10 contain all available control variables whose summary statistics are presented in table 5.[59] Time dummies are always included.

All results, except those in columns 5 and 10, represent RE estimates. Those in columns 5 and 10 represent maximum likelihood estimates described in the appendix, which take into account the possibility that LCAs may be entering strategically on those routes on which DB offers unattractively high prices, using the airline network variables described earlier as (excluded) instruments. In general our model appears to very robustly explain the variation in the data. The R-squared, reported in the bottom row of both the top panel and the bottom panel ranges from 0.58 for lpkm2 and 0.77 for lavprice2 in our model with additional controls.

Table 5: Long Term Effect of LCA Entry on DB outcomes

	Complete sample					Additional controls				
	Random effects				ML	Random effects				ML
Column number	1	2	3	4	5	6	7	8	9	10
Depend. variable	lpax	lavprice	lrev	lpkm	lavprice	lpax	lavprice	lrev	lpkm	lav-price
					Second class					
Long term effect of LCA entry (δ)	- 6.8%**	2.4%	- 4.5%	- 8.9%**	-27.0%***	-17.0%***	0.0%	-16.7%***	-16.4%***	-17.6%***
No. obs	4421	4415	4415	3527	4415	1652	1652	1652	1652	1652
No. O&Ds	207	207	207	168	207	84	84	84	84	84
R-squared	0.394	0.45	0.43	0.279		0.684	0.767	0.641	0.578	

59 Differing sample sizes for the complete sample reflect missing observations for the dependent variable.

	Complete sample					Additional controls				
	Random effects				ML	Random effects				ML
First class										
Long term effect of LCA entry (δ)	0.003%	2.5%	3.8%	1.0%	-15.6%***	-18%***	3.6%**	-15.7%***	-23.1%***	-19.7%***
No. obs	3916	3886	3886	3325	3886	1634	1631	1631	1634	1631
No. O&Ds	201	201	201	168	201	84	84	84	84	84
R-squared	0.498	0.588	0.439	0.238		0.758	0.757	0.744	0.715	

Note: The percentage values in this table represent the percentage change in the dependent variable mentioned in each column heading resulting from LCA entry and operation over our sample period. They capture the long term effect of LCA entry. Each column in the top panel and each column in the bottom panel represents a different regression equation. The complete sample estimates in columns 1-5 contain the complete sample controls: presence06, domestic, lcoal, lkerosene, loil, ldistance lorig_pop, ldest_pop, lauto_dur, and ICE. Estimates for the model with additional controls in columns 6-9 contain all control variables. Differing sample sizes for the complete sample reflect missing observations of the dependent variable. Time dummies are always included. The first four columns and the last four columns are the marginal effects associated with the random effects (RE) estimates and column 5 is the maximum likelihood estimate, which corrects for endogeneity in the form of selection bias. The instruments used in the selection equation presented in column 5 are lairlines_orig lairlines_dest. The percentage values reflect the correction necessary to interpret the marginal effect of a dummy right-hand-side variable with a log dependent variable, so z%=exp(x)-1, where x represents the point estimate in the RE estimation. These regressions are presented in entirety in the appendix. For lpkm, ldistance is dropped. *** p<0.01, ** p<0.05, * p<0.1.

The estimates in columns 1 and 6 suggest that LCAs have a strong negative effect on rail passenger numbers. In our complete sample, this amounts to a 6.8% reduction of passenger numbers in the second class. In our model with additional controls, containing a higher proportion of O&Ds covering large domestic routes on which DB offers high quality services and where airlines are already operating multiple services at the beginning of our sample period, this reduction amounts to a substantially larger 17.0%. For first class, we find no passenger effect in the complete sample, but a negative effect of similar magnitude to that in second class (-18.0%) in our model with additional controls. Our data therefore suggests that:

- LCA entry and operation is associated with at least a 7% reduction in second class rail passenger numbers. This result is robust to a large number of controls.

- LCA entry and operation is associated with no significant change in first class passenger numbers in our complete sample. It is associated with an 18% reduction in first class passenger numbers in the model with additional controls comprising a more limited sample of 84 O&Ds covering large domestic routes on which DB offers high quality services and where airlines are already operating multiple services at the beginning of our sample period.

That LCAs should have a negative impact on second class passenger numbers seems logical given that second class DB customers are likely to be (quality-adjusted) price sensitive and such price sensitive customers are precisely those attracted to LCAs. What comes as something of a surprise is that in a subsample for which we have additional controls, the first class passenger effects associated with LCA entry and operation are significantly negative, large in absolute value, robust to a large number of controls, and comparable to the impact in second class for the same O&Ds. Since LCAs tend not to be the transport mode of choice for business clientele, this finding may reflect the fact that national carriers (such as Lufthansa) often react to LCA entry by lowering their prices. And such offers are likely to be attractive to DB first class passengers.

The estimates presented in column 2 suggest that in the complete sample, LCA entry and operation (henceforth signified as “LCA”) have no impact on DB average prices in either first or second class. The 2.4% to 2.5% increase for both classes is statistically insignificant. As suggested earlier, the possibility exists that this is biased upward through O&Ds that have experienced entry being precisely those where DB offers, from the passenger’s perspective, unattractively high prices. This concern finds some confirmation in the bottom half of column 7, which suggests for the smaller sample, for which a larger set of controls are available, that LCA entry has a significantly positive effect on first class prices.

Columns 5 and 10 correct for endogeneity in the form of selection bias. Once we correct for the possibility that O&Ds experiencing entry over our sample period may be different from those not experiencing such entry, we find a large, significant, negative effect of LCAs on DB prices in both first and second class. Our ML estimates for the complete sample (column 5) suggest that LCAs result in a 27.0% fall in second class prices (row 1) and a 15.6% fall in first class prices. The ML estimates in column 10 suggest that this decrease is robust in the restricted sample with additional controls; LCA entry is associated with a 17.6% decrease in second class prices and a 19.7% decrease in first class prices in this case.

The magnitude of these effects need to be treated with caution: IV estimates with binary endogenous variables are typically imprecise and the ML estimation we apply may not be particularly robust. What is true, however, is that our instruments perform very well for the price equation specifications for both first and second class in column 5 and for the first class prices in column 10.[60] Moreover, as appendix regression tables for lavprice1 and lavprice2 indicate, the estimates presented for the complete sample reflect the most conservative of our IV estimates. This leads us to conclude that

- LCA entry and operation likely puts significant downward pressure on average DB prices in both first and second class.

The estimates in columns 3 and 8 indicate an insignificant long term effect of LCAs on both second and first class revenues. However, the effect is large and negative in the case of the model with additional controls, with point estimates suggesting that for this sample of 84 O&Ds, LCAs are associated with a 16.7% reduction in second class and 15.7% reduction in first class revenues. In summary:

- LCA entry and operation is associated with no significant change in rail second class revenues for the complete sample. It is associated with a 16.7% reduction in second class revenues in the model with additional controls comprising a more limited sample of 84 O&Ds covering large domestic routes on which DB offers high quality services and where airlines are already operating multiple services at the beginning of our sample period.
- LCA entry and operation is associated with no significant change in first class revenues for the complete sample. It is associated with a 15.7% reduction in first class revenues in the model with additional controls comprising a more limited sample of 84 O&Ds covering large domestic routes on which DB offers high quality services and where airlines are already operating multiple services at the beginning of our sample period.

The revenue results for second class follow from the fact that, for the complete sample, the zero price effect dominates the negative passenger effect. For the first class complete sample, it follows from the fact that both the price and passenger effect are not significantly different from zero. The large negative result for the model with additional controls follow a similar logic in that they stem from the fact that the large negative passenger effect dominates the price effect. This means that even in the absence of any price effect, the loss of passengers that has accompanied competition from LCAs (either directly or as a result of competitive reactions from national carriers) has culminated in large reductions in revenues in both first and second class.

The last set of results, presented in columns 4 and 9, pertains to passenger kilometers. These results suggest that in the complete sample, LCAs are associated with an 8.9% decline in second class passenger kilometers and no significant decline in first class passenger kilometers. In the model with additional controls, there is a 16.4% decline associated with LCAs in second class

[60] For the complete sample (column 5) A Sargan-Hansen test of overidentifying restrictions indicate that we cannot reject the null hypothesis that the instruments are valid, i.e. uncorrelated with the error term (the Hansen J p-value is 0.28 for second class and 0.378 for first class), Kleinbergen-Paap tests for under- and weak-identification are also strongly rejected in each case. For the specification with additional controls (column 10), the Hansen J p-value for second class is 0, which suggest that our instruments are not valid for this sample. The Hansen J p-value for first class prices is 0.361 for the specification with additional controls, and the Kleinbergen-Paap tests for under-identification and weak identification are strongly rejected.

passenger kilometers and an even larger 23.1% decrease in first class passenger kilometers. In summary:

- LCA entry and operation is associated with an 8.9% decline in second class passenger kilometers for the complete sample. It is associated with a 16.4% decline in second class passenger kilometers in the model with additional controls comprising a more limited sample of 84 O&Ds covering large domestic routes on which DB offers high quality services and where airlines are already operating multiple services at the beginning of our sample period.
- LCA entry and operation is associated with no significant change in first class passenger kilometers for the complete sample. It is associated with a 23.1% decline in first class passenger kilometers in the model with additional controls.

The fact that we observe a fall in second class passenger kilometers but not in passenger numbers in the complete sample reflects the high likelihood that DB faces the largest competitive pressure on particularly distant O&Ds. This appears to be especially true of first class passengers in the model with additional controls, where the point estimate is more than 7 percentage points lower (i.e. more negative) than it was in the case of passenger numbers.

Conclusions

The panel data analysis indicates that there is robust evidence for effective competition between low cost airlines and rail operators affecting first and second class passenger numbers, price revenues, and passenger kilometers to various degrees.

Most importantly, LCA entry has a negative long-term effect on passenger numbers. Second class passenger numbers in our complete sample of 207 O&Ds fall by 7% upon LCA entry. In the more limited sample comprising 84 O&Ds covering large domestic routes on which DB offers high quality services and where airlines are already operating multiple services at the beginning of our sample period, LCA entry is associated with an even larger 17% reduction in second-class and an 18% reduction in first class passenger numbers; these reductions are robust to a large number of controls.

The negative impact of LCAs on second class passenger numbers is likely to reflect the fact that these rail customers are (quality-adjusted) price sensitive and are thus attracted by LCAs. The negative effect associated with first class passenger numbers may reflect the fact that although LCAs tend not to be the transport mode of choice for business clientele, national carriers (such as Lufthansa) often react to LCA entry by lowering their prices. And the national carriers are likely to be attractive to first class rail passengers.

Regarding prices our finding is that, controlling for the possibility that LCA entry on a given O&D at a given point is not a random decision but rather a strategic one, LCA entry is likely to put significant downward pressure on rail ticket prices in both first and second class.

With respect to DB revenues, we find that LCA entry is associated with no significant long-term change in second class revenues for the complete sample. However, the large negative passenger effects in our limited sample comprising 84 O&Ds is reflected in a corresponding 16.7% reduction in second class revenues and a 15.7% reduction in revenues for these O&Ds. This result is robust to a large number of controls and suggests that even in the absence of any price effect, the loss of passengers that has accompanied competition from LCAs (either directly or as a result of competitive reactions from national carriers) is likely to culminate in large reductions in revenues in both first and second class on many major O&Ds.

In addition, LCA entry and operation is associated with an 8.9% decline in second class passenger kilometers and no corresponding change in first class passenger kilometers for the complete sample. In the limited sample of 84 O&Ds for which the result is robust to a large number of controls, it is associated with a 16.4% reduction in second class and a 23.1% reduction in first class passenger kilometers. The fact that we observe a fall in second class passenger kilometers but not in passenger numbers in the complete sample reflects the high likelihood that a rail operator faces the largest competitive pressure on distant O&Ds.

5.4
Scenario analysis

The second part of our quantitative analysis is related to intramodal competition and the likelihood of entry into the high-speed rail segment after the implementation of the Third Railway Package in 2010. This scenario analysis is based on a cost and revenue model for individual O&Ds, accompanied by various qualitative indicators, and is carried out in various steps. In the following section the methodology is described. We then present the main results.

Methodology

In general, entry is driven by profitability after entry. Despite relevant data on ex ante profit margins, costs, and demand data, calculating post-entry profitability requires an explicit model of competition.[61] The approach taken within this report—a scenario analysis based on a model of ex ante profitability and qualitative indicators—is less ambitious theoretically but allows more flexibility in taking into account various dimensions of changes in the competitive environment. Due to the fact that our analysis necessarily has to be speculative,

61 See for instance Ivaldi and Vibes (2005) for a simulation analysis based on a theoretical model.

with regulatory uncertainty being one of the most important factors of exogenous risk in this particular industry, the scenario-analysis approach seems to us the optimal one.

The backbone of the scenario analysis is a revenue and cost model for individual O&Ds. Based on this R&C model, we derive operational profit of individual O&Ds assuming costs figures used in a study by Steer Davies Gleave and DB revenue data. Furthermore, we calculate total profit of an O&D by subtracting fixed costs (capital costs, overhead, etc.). While these figures can explain the low entry level currently observable—assuming that pre-entry profitability provides an upper estimate of post-entry profitability—future profitability is by definition required to assess future entry. Accordingly, we adjust our R&C model, drawing some reasonable but optimistic assumptions regarding future revenue growth and costs.

Based on this model of future pre-entry profitability, various entry strategies are discussed, focusing particularly on the strategic impact of a public service operator levy and network effects on the likelihood of one or the other entry strategy being pursued. Both factors—the public service levy and the network effect—can be strategically used in, especially, an environment of asymmetric liberalization. Furthermore, various scenarios integrate regulatory interventions like joint ticketing and "hop on the next train."

R&C model: Structure and assumptions

The long-run profitability of an individual O&D is likely to ultimately determine the entry decision of an independent entrant or the expansion of an incumbent rail operator from a neighboring territory. As a proxy for future expected profits, the pre-entry profitability of an individual O&D is measured with a detailed cost and revenues calculation that is based on revenues and passenger data provided by Deutsche Bahn as well as cost estimates derived from both the empirical literature and studies with simulations.

- Revenues

The revenue input of the profit margin calculation is based on revenue figures of individual O&Ds for the October 2006-October 2007 period. The data is disaggregated according to ICE and IC ticket sales for domestic O&Ds and overall ticket sales for international O&Ds, i.e. in the latter case no differentiation between the speed range up to 200 km/h and beyond that range is possible. However, both domestic and international data distinguishes between first and second class passenger numbers and sales. Because of the variety of prices and special tariffs available to train passengers, a weighted average of the price for first and second class travel as well as for ICE and IC journeys (only domestic) is calculated on a monthly basis for the period of observation. Value-added tax

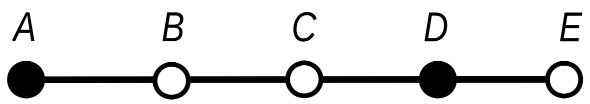
(VAT) has to be deducted from the overall revenues in order to obtain the net revenues for Deutsche Bahn.[62]

The calculation further relies on data regarding the daily frequencies of ICE and IC trains on a given O&D[63] and provides average revenues for a single train trip on that specific O&D. In addition, the average yield on the route (in euros per passenger kilometer) is calculated, thereby providing a base for comparison between individual O&Ds. The average yield of the O&D universe is higher than the official EBIT per person kilometer of 9,56 €-cents in long-distance rail passenger traffic (2007), which indicates a slightly more lucrative composition of routes than the average of long-distance rail passenger traffic.[64]

The decentralized, non-radial characteristics of the German rail track infrastructure reflect the demographic distribution of a country without a clear center like London in the UK, Paris in France, and Madrid in Spain. This structure induces a substantial passenger flow between stops other than origin and destination on a given route; this flow has to be taken into account when looking at an individual O&D. Since we have only obtained the actual passenger numbers between origin and destination, an estimate of additional passengers is necessary.

In principle, two sorts of additional passengers are possible—intermediate and transfer passengers—as seen on the following graph.

Figure 7: Prototype representation of the calculation rationale of transfer and intermediate passengers



Source: ESMT CA

If the O&D connects city A and city D, the first extension of passenger numbers stems from passengers on intermediate stops (“intermediate passengers”). Intermediate passengers are those who travel on any sub-segment between A and D, such as from A to B, or those which travel from B to C. To get a measure of overall revenue produced on a particular O&D, these passenger revenues have to be added to the revenue produced by direct passengers.[65] This methodology is also applied to calculate the extra passengers on an O&D due to cabotage.

62 On January 1, 2007, VAT rose from 16% to 19%. We take this change into account by taking the weighted average of VAT over the observation period, i.e. 3 months of 16% and 9 months of 19%, and deduct it from the DB figures.

63 This data has been collected from the 2007 DB schedule. When no historical frequencies are available for a given O&D, the current schedule has been used.

64 International routes may have higher yields due to more sophisticated techniques in yield management. The British Airways/Eurostar case for example, as discussed in section 3.4, reports a yield per passenger of around €70-€100, which translates into 14-20 €-cents.

65 We measure the number of intermediate passenger based on the following methodology: We establish a matrix depicting all possible combinations of all stops on each O&D and count the

Furthermore, transfer passenger revenues have to be added to the O&D specific revenue figures. For example, the revenue figures for shorter routes like B-C do not include revenue data of passengers who travel on all longer routes (like A-D, A-C, and A-E). Using the same methodology as for intermediate passengers, we control for this by estimating the number of transfer passenger on a particular O&D.[66]

Notably, the estimated numbers of intermediate and transfer passengers offer only a rough idea of the network effects in the German rail system and suffer from several simplifications. In particular, our dataset does not contain all possible combinations of destinations within Germany and selected destinations in Europe, but a sample of only 207 O&Ds in total. Hence, many transiting or intermediate passengers who use the trains are not registered; in total, this may induce a downwardly biased estimate of the revenues. However, a comparison with estimates from Intraplan data based on passenger flows for 2005 shows that we structurally overestimate passenger numbers for a subset of 135 available observations, but the difference between our estimates and the Intraplan passenger numbers is not significant.[67]

Network profitability is thus an indicator that has to be dealt with cautiously. It nevertheless helps to understand the importance of cabotage and its impact on the profitability on both longer routes and relatively short O&Ds.[68]

- Costs

The second major input for the ex-ante profit margin is cost data, consisting of two components, variable and fixed costs. These are both denoted in train kilometers.

number of occurrences of every intermediate combination as a subset of another O&D. We then divide the total revenues of the intermediate O&D, e.g. between B and C, by the number of times in which it occurred in the dataset, thereby spreading all intermediate passengers evenly on all longer O&Ds and adding the corresponding fraction of revenues to each longer O&D, including A-D. However, given the limited number of observations available for this study and the meshed character of the German rail network the exact amount of additional passengers on intermediate O&Ds is highly difficult to estimate.

66 We again use the matrix of all O&Ds to determine whether any longer route induces increased passenger flows on a shorter one. For each O&D, we determine how often it is a subset of any other route and divide the combined first and second class passenger numbers by the amount of occurrences in the sample in order to avoid double counting. We then multiply the average amount of passengers by the average revenues on the shorter O&D to get an estimate of the additional revenues generated by transfer passengers.

67 The p-value for the comparison lies, with 14%, well above the significance level of 5%. Any value below 5% would indicate that the means would have to be considered as different.

68 For example, on a typical O&D annual revenues from passengers travelling between two cities are estimated to amount to €1.53 million, based on DB data. The calculation for intermediate and network passengers adds revenues of €314,000 and €120,000, respectively. Within this approach it is not possible to calculate an overall network effect across all O&Ds, though, because the analysis is based on potential additional passengers on each O&D separately. Hence, if all intermediate and network passengers were added to the total observed revenues of the O&D universe, some of the passenger numbers and corresponding revenues would be double-counted, because they appear on routes as the original revenue figure as well as the amount shared by intermediate and/or transfer passengers. However, in a comparison between the actual, observed annual revenues of around €402 million for the O&D universe, intermediate passengers are independently calculated to contribute €379 million and network passengers would, again independently, account for €172 million.

The variable costs have been derived from data provided by Steer Davies Gleave (2006) in their assessment of costs of an entrant on a German O&D (Cologne-Frankfurt). The variable cost component contains the subcategories "energy", "drivers and other on-train staff," and "rolling stock maintenance," which have been assigned monetary values per train kilometer in this Steer Davies Gleave (SDG) study. The table below provides figures for a sample O&D. Rolling stock maintenance bears a variable cost and a fixed cost component; hence, we have split the SDG estimate by half for each cost factor and allocate 50% of the rolling stock maintenance costs to the variable costs. Given that the Steer Davies Gleave figures are only estimates for one recently opened high-speed, high-profile O&D, we discount 20% of each cost driver to approach the likely cost of operation on the whole network. The variable costs per train kilometer are multiplied by the distance of an O&D, the frequency of trains per day on that O&D, and the amount of days per year, in order to obtain variable cost figures for each O&D in a given year. This method does not take efficiencies of network operations into account but treats each route as a stand alone service, thereby approaching the actual costs of an entrant without the network backups while overestimating the costs for the incumbent benefiting from network synergies.

The variable cost data is complemented by figures on access prices from the Deutsche Bahn "Trassenpreise"-CD-ROM for the year 2007.[69] While the prices for the fastest and therefore most expensive link are assigned to each ICE trip, intercity journeys are based on the cheapest track access. On some O&Ds, the difference between the two price figures can be substantial, e.g. on the route from Frankfurt to Munich the fastest tracks cost €2,743, whereas the cheapest option available costs €1,512. The average access price across the sample is €4.62/km for the more expensive tracks and €3.56 for the cheaper routes. Domestic access prices are on average higher (€5.38/km for fast tracks and 3.65/km for slower ones) than average access prices abroad (€3.11/km and €2.91/km, respectively). The access prices are then multiplied by the total amount of trains operating in a given year in order to obtain annual cost figures for the operator.

The cost data is further composed of fixed costs. Under this category, the following items are summarized: the remaining 50% of "rolling stock maintenance," "ticket sales," and "administration and overheads." Average numbers per train kilometer are then calculated, based on Steer Davies Gleave (2006) data, and again discounted by 20%. However, network effects and the resulting efficiencies from joint operations of maintenance, sales, and administration are not taken into account.

For the calculation of capital costs, we use annuities of the investment in rolling stock. In our approach, we assume that all trains that are operating on a given O&D have to be purchased and are not a priori available. This assumption can be

[69] Since Deutsche Bahn only releases the track prices for its own network, the additional data for the portion of the journey on foreign territory was gathered from the EICIS web database. In the case of France, individual spreadsheets from the grid operator RFF were used.

maintained in a setting where trains have to be replaced after completion of their technical life span. The input factors for the annuities calculation are about €23 million in the case of a high-speed train like the TGV or ICE, and about €12 million for an intercity train.

The investment volume of €23 million is based on the announced investment of the Spanish railway company Renfe to buy a total of 32 high-speed trains for the Madrid-Barcelona route for €740.4 million in 2001. Although the purchase was already announced several years ago, this value can be used as a proxy, since it does cover a high-speed technology of not only one company, but provides an average of 16 trains based on ICE-3 technology manufactured by Siemens and 16 trains of Talgo Adtranz.[70] The €12 million for an intercity train are based on RailPag estimates released by the UK government (Guidelines, 2006). The amount also corresponds to the Siemens Railjet technology, which can reach a speed of up to 230 km/h and of which 23 trains have recently been acquired by the Austrian rail company ÖBB.[71]

The assumptions related to the capacity of the trains are based on 673 passengers for a high-speed train (which is the average passenger capacity of ICE 1, ICE 2, and ICE 3, with respective capacities of 743, 740, and 536 seats) and 638 passengers on an intercity train. More specifically, the capacity of 743 seats in the ICE 1 includes the 40 places in the on-board restaurant, beside the 197 places in the four cars of the first class and 506 places in the seven cars of the second class.[72] The ICE 2 has 105 places in the first class and 275 places in the second class in its standard configuration.[73] Since this study examines predominantly O&Ds on popular routes, it is assumed that for each O&D two coupled ICE 2 trains are provided, which basically doubles the available capacity. For the ICE 3, a capacity with 536 seats is assumed, based on a design study Siemens of the Velaro HP,[74] which contains ICE 3 technology. This extended version of the ICE 3 has to be understood as the upper bound of the seating capacity of the rolling stock a new competitor in the scenario analysis would order. The 638 seats of a prototypical intercity train is based on data used in the Copernicus Institute/ University of Utrecht simulation model "Clean Energy Supply 2050."[75] Similar to the estimate of the ICE 3, a capacity is rather overestimated than underestimated. The reason for this latent overestimation is

70 Another cost figure for high-speed trains would have been Nuovi Trasporti Viaggiatori's contract with Alstom over 25 AGV trains with a unit price of €26 million, as negotiated in January 2008. However, the Alstom trains can be considered the expensive high-end segment of the market for high-speed trains, and in a scenario framework with „reasonable but realistic" assumptions a slightly lower price for rolling stock seems appropriate.

71 As is stated on ÖBBs website: "Railjet is faster, more modern and more comfortable than any other train service currently operated on the Austrian rail network. The 23 multiple-unit Railjet trains will be operated in two-hour intervals on Austria's Western rail axis between Vienna and Bregenz and between Bregenz and Munich. With a maximum speed of 230 km/h, journey times will be markedly reduced. The journey from Vienna to Innsbruck will take no more than four hours and to Salzburg no more than two hours and ten minutes." Retrieved from http://www.railjet.at/.

72 See also "ICE 1 im neuen Design: Mehr Komfort für Bahnkunden", http://www.eisenbahn-webkatalog.de/news/index.php?newsid=1068, retrieved on Aug. 14, 2008.

73 See also "ICE 2 (class 402, 805, 806, 807 and 808)", http://www.railfaneurope.net/ice/ice2.html. Retrieved on Aug. 14, 2008.

74 See Brockmeyer et al. (2007).

75 For further information see Treffers (2001).

the calculation of the load factor, which becomes relevant in the scenario analysis of an independent entrant. In these scenarios, the entrant reduces the amount of trains in order to correspond to a 100% load factor on each O&D, which results in a substantial cost advantage due to a more efficient use of the rolling stock. The higher the initial estimates of the train capacity, the lower the observed load factor, and hence the lower the requirements for additional trains.

Average speed is assumed to be 150 km/h for high-speed trains and 110 km/h for intercity trains. These estimates take the specific German network structure with multiple stops and rail tracks of different quality levels (and speed restrictions) into account. The technical life span of a train is estimated to be 25 years, with a residual value of 10% of the initial purchasing price. Given these input variables, the annual capital costs for a high-speed (ICE) train amount to about €2.20 million per year, and for an intercity train to approximately €1.16 million. As indicated, the frequencies are used to calculate the minimum amount of ICE and IC trains needed to provide full service by taking into account the traveling time between origin and destination, thus providing a rough estimate of the capital costs involved in the operation of a specific O&D.

For data gathering reasons, this calculation does not take into account that network logistics and applied optimization algorithms may reduce the number of required trains; it rather assumes that each O&D is an individual observation. Important network effects that an incumbent operator can use to its advantage are therefore not taken into account, which induces an upward bias in the cost estimates and ignores the economies of scale a rail service provider can achieve when operating trains on multiple routes. In addition, track access costs may be double-counted for some O&Ds when trains are used for multiple destinations, e.g. in figure 7 the tracks are counted twice for a train that originates in A and heads to D and then to E, thereby further overestimating the actual costs of the incumbent operator.

Table 6 shows the combined cost figures and estimates for an exemplary O&D from the sample.

Table 6: R&C model: Example of cost assumptions

ICE Variable costs			
Steer Davies Gleave	Drivers and other on-train staff	Euro per train kilometer	1.14
	Rolling stock maintenance	Euro per train kilometer	1.38
	Energy	Euro per train kilometer	1.35
	Variable costs (excl. station costs)	Euro per train kilometer	3.88
	Variable costs	*Euro per train*	*1102.46*
Access charges	Fastest	price (euro)	1816.10
	Cheapest	price (euro)	1101.14
	Total variable costs SDG & access charges excl. capital cost	**Euro per train**	**2918.56**
ICE fixed costs (excl. capital costs)			
Steer Davies Gleave	Rolling stock maintenance	Euro per train kilometer	1.38
	Ticket sales	Euro per train kilometer	2.43
	Administration and overheads	Euro per train kilometer	2.48
	Fixed costs (excl. capital costs)	**Euro per train kilometer**	**6.29**
	Total fixed costs	*Euro per train*	*1789.65*
Capital costs	Number of trains	Integer	2
	Capital costs	Euro per train	2 203 894.36
	Total capital costs	**Euro per year**	**4 407 788.72**
Total costs	**Total costs per year**	**Euro per year**	**21 592 746.37**

Source: ESMT CA, Steer Davies Gleave (2006), DB Track access charges (2007), various (see above); access charges and capital costs refer to actual train frequencies and publicly available access charge data by DB.

With the total estimated passenger numbers on each O&D, including the passenger kilometers of intermediate and transfer passengers, the actual frequencies of trains per day and the capacity of each train, an average load factor per O&D can be calculated. This load factor can exceed 100% on some O&Ds, because some passengers may use train connections that have multiple transfers or are slower regional trains and thus are not accounted for in the frequencies. However, the average load factor of the full sample is 42%, which corresponds to the load factor indicated by DB for its long-distance transport business unit in 2007 (see Annual Report DB, 2007, p. 64).

The flexibility of the R&C model makes it feasible to modify input figures and adapt them to different scenarios. In section 5.4: Entry analysis 2010 – Strategies (page 96) we will use the possibility of changing variable and fixed costs to simulate the efficiencies of an independent entrant, in a manner modeled on the cost reductions achieved by low-cost airlines vis-à-vis incumbent operators. In addition, the number of frequencies can be adapted to the actual load factors on individual routes; this reduces capital costs, thus increasing the profitability of a given O&D. However, the model does not attempt to estimate demand elasticities (own and cross) for the routes in the sample and does not provide the methodological framework to properly analyze expansion effects resulting from, e.g., price decreases. It only serves as a tool to determine the stand-alone profitability of a route with a given price and passenger level.

- Operating profit and total profit

The revenue and the cost components of the model can be combined to give an indication of the overall profitability of an individual route. We suggest concentrating on two measures of profitability, operating profit and total profitability.

The operating profit can be interpreted as a measure of a company's earning power from ongoing operations, equal to earnings before deduction of interest payments and income taxes, also called EBIT (earnings before interest and taxes) or operating income. It includes all variable costs, i.e. in this model costs for energy, drivers, and other on-train staff as well as access costs of the ongoing operations. The operating profit or EBIT is a common measure for overall profitability of a firm in network services, because often the high fixed costs or high investment costs in capital-intensive industries drive the profitability down although the venture’s continuing operations are profitable.[76]

Total profit is different from operating profit in the way it is constructed, because in addition to the variable costs and access prices it takes fixed costs and capital costs into account. These additional factors drive the total profit and the overall profitability down but more adequately represent the actual expenses a rail operator faces, especially when new rolling stock is involved.

[76] For example, see the decision of the French competition authority in the case Eurostar vs. British Airways, where Eurostar figures only take the operating profits into account, while the debt levels and capital costs associated with the operations of the tunnel are not considered (Décision n° 07-D-39 du 23 novembre 2007 relative à des pratiques mises en oeuvre dans le secteur du transport ferroviaire de personnes sur la route Paris-Londres, p. 17).

In the following section, we discuss the results of the R&C model based on the above-furnished data, extended network revenue estimates, and cost assumptions, while the subsequent sections will present modifications of the base model in line with likely developments up to 2010.

R&C model: Results

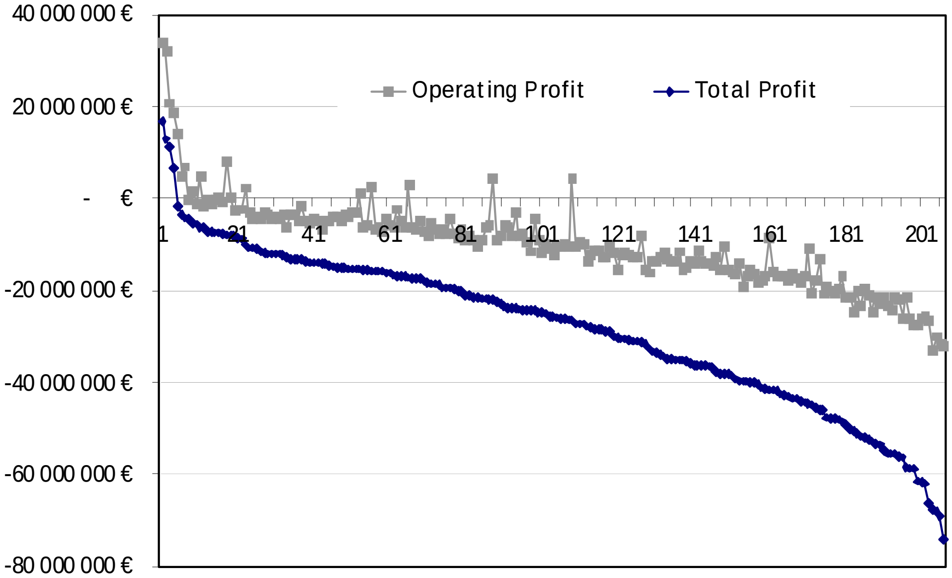
The revenues and cost model offer an indication of the profitability of DB routes on an individual O&D level both for operating profitability and total profitability. In the following we present O&D-specific profitability based on current (status quo scenario) and future (base scenario 2010) cost and revenue figures.

Pre-entry profitability: Status quo scenario

Based on the R&C model we find an overall low level of profitability with respect to total profit. Of the total of the 207 O&Ds, only four break even. All of these routes are domestic. Furthermore, we can observe higher losses on the O&Ds that are unprofitable than profits on the profitable O&Ds, i.e. the average profitability across the sample is negative. With respect to positive operating profits, international O&Ds have a share of slightly more than a third with 5 out of 18 observations. International routes are thus underrepresented in the group of profitable O&Ds (representation in the overall sample is 62%). The international O&Ds benefit from strong passenger traffic on intra-German routes. They typically have low numbers of customers who actually travel to the final destination, but they pass through populated areas in Germany and thus carry a high number of intermediate passengers. This can be demonstrated by taking the ratio of the sum of the (city, not catchment area) populations in intermediate stops over the sum of the populations in origin and destination. All routes that are ex ante profitable with respect to operating profits have an average intermediate/O&D ratio of 2.10 and 2.22 for, respectively, ICE and IC connections; i.e. more than twice as many people live in intermediate stops than in the end locations of the route. Focusing on the sub-sample of only profitable international O&Ds, this ratio rises to 6.51 and 6.44. In contrast, the average intermediate passenger to O&D ratio for the rest of the sample is centered around 1.44 and 1.53 for ICE and IC services, respectively.

The following graph furnishes an overview of all O&Ds in the sample, with respect to the two indicators total profit and operating profit, ranked by total profit.

Figure 8: Total and operating profit of individual O&Ds, based on revenues, access charges, and cost estimates



Source: ESMT CA

As the numerical results in figure 8 indicate, the profitability of the status quo scenario is negative in more than 90% of the sample. DB profitability figures in the long-distance passenger rail segment show that the overall financial results were positive in 2007, though. There is a number of reasons why this assessment does not reproduce the total figures of DB Fernverkehr for the given O&D universe, which are listed in the following section.

Differences to actual DB long-distance passenger rail profitability

According to the financial statements of DB, long distance passenger traffic was profitable in 2007, with a total of €3.265 million revenues and a profit of €139 million. This results in an average revenue of 9.56 €-cents per passenger kilometer in long-distance rail passenger traffic (2007) and an average profit of €0.04 per passenger kilometer. For comparison: within our O&D universe we measure an average revenue of 10.31 €-cents per person kilometer for the ICEs and 9.84 €-cents for the ICs, while the average profit is negative. Our sample may therefore be biased towards the more profitable routes with respect to revenues, but may suffer from an over-estimation of the cost figures.

It has to be emphasized that this study does not intend to reproduce the Deutsche Bahn results, but assesses the likelihood of entry of competitors of the Deutsche Bahn by calculating their profitability in various entry strategies. In particular, the following reasons are responsible for the differences between the net results of DB Fernverkehr and our assessment:

- **Network efficiencies and economies of scale.** Most importantly and as already indicated in section 5.4: R&C model – Structure and assumptions (page 82), the model used here treats each O&D as a stand-alone venture, thereby partly overestimating the actual costs of the incumbent operator, since e.g. track costs are double-counted for some O&Ds. In particular, all routes that have a duplication of trains for passengers, variable costs, and track prices are counted as many times as a route is used by a specific O&D, thus ignoring the effect of network efficiencies and economies of scale. For example, if all passengers from A to D in figure 7 change trains in C to use the trains traveling from A to E, the variable costs and track access charges are still counted as *if* two separate trains services were running.
- **Cost estimates of individual O&Ds.** A second major caveat regarding the R&C model is that correct cost figures on an O&D level are not publicly available. The Steer Davies Gleave estimates used in the model are based on fictive entrant costs for the route Frankfurt-Cologne and may not be representative for the overall O&D universe. Furthermore, they are based on *costs per train kilometer*, which means that they are multiplied by the distance of an O&D, the frequency of trains per day on that O&D, and the amount of days per year. This calculation may lead to an over-estimation of fixed costs for longer O&Ds, especially in costs related to ticketing, marketing and maintenance.
- **Capital costs and depreciation of rolling stock.** Capital costs are difficult to verify in actual contract conditions, since they often include long-term maintenance clauses and are thus upwardly biased. The capital cost estimates used in the model are based on publicly available data of historical acquisitions of rolling stock; an incumbent service provider like Deutsche Bahn may be able to negotiate more favorable prices, especially because of larger amounts of rolling stock required. In addition, capital costs heavily depend on the rate of depreciation applied. The overall life span of 25 years, which is assumed in the model, may not correspond to actual figures applied in the calculation of depreciation of an incumbent. While the R&C model assumes that constant renewal of the rolling stock is required for the operations, an alternative cost scenario may be based on substantially reduced capital costs, because the bulk of wagons and locomotives is already fully depreciated but still entirely functional, and new rolling stock is not (yet) necessary for the operation of services on a given O&D or the entire network.
- **Sample selection.** As indicated in section 5.2, the 207 O&Ds analyzed in this assessment are fairly equilibrated regarding domestic and international routes as well as routes with and without competitive threats from aviation. However, they were selected under criteria of *long-distance* passenger

transport. This implies that especially many of the shorter routes between medium-sized cities, e.g. in the Ruhr area, in the Frankfurt-Mannheim region or in the densely populated surroundings of Stuttgart, which are all part of the DB long-distance rail network and have ICE or IC stops, are not taken into account, although they may be used by large amounts of commuters and highly profitable on individual routes segments. Given that the revenues of the O&D universe of this study only account for 12% of a total of €3.265 million revenues of DB long-distance rail passenger transport (according to the financial statements of DB long-distance passenger transport for 2007), it has to be highlighted that the bias towards longer and international routes is likely to reduce the average profitability of the sample.

In sum, several factors contribute to the lack of comparability between the positive net gains of DB long-distance passenger services and the negatively biased result of this study, including cost savings due to network effects and economies of scale, duplication of costs because of the O&D focus of this analysis, different accounting and depreciation methods, as well as a sample selection bias towards longer-distance routes and international routes. However, the objective of assessing the likelihood of entry on an *individual* O&D, based on total and operational profitability, is only threatened by the uncertainty in the underlying cost estimates. As stated in section 5.4: R&C model – Structure and assumptions (page 82), we suggest taking this uncertainty into account by deducting 20% of each cost driver of the Steer Davies Gleave estimates.

Pre-entry profitability: Base scenario 2010

While given the low or negative margins, under current market conditions entry in the German long-distance rail passenger transport seems unlikely, one of this study's objectives is to examine whether the profitability of individual O&Ds will change significantly in the near future, thus creating conditions making entry of new competitors in long-distance passenger travel more likely than under current circumstances. Various factors may in fact influence profitability in a positive way. We outline these general trends and translate them into reasonable positive estimates of future demand and costs. More precisely, the following assumptions have been made:

i. **Demand for rail transportation services is expected to increase:** According to recent estimates, overall demand will increase around 1.5% annually until 2010; this translates roughly into 5% from the observation period until 2010.[77]

ii. **An increasing share of rail transportation is expected in the overall modal split:** Due to increasing fuel costs, through which airlines and individual car owners/ users are much more severely affected than train passengers, it can be reasonably argued that rail transportation will become more competitive

[77] See Servrail study (2006), p.24. According to the authors rail passenger transport (measured in passenger kilometers) will increase by 1.5% annually until 2010 for Germany, Switzerland and Austria, and slightly slower thereafter. Growth in other neighboring countries that are part of our O&D universe (i.e. France, the Netherlands, Belgium, and Denmark) will grow at slightly higher or lower rates (France, the Netherlands, and Belgium are expected to grow by 1.8% p.a., Denmark by 1.2%).

vis-à-vis other means of transport.[78] Already in mid-2008, several news reports have indicated that around 20 million more passengers used both regional and long-distance rail services in the first quarter of 2008 compared to 2007, with ICE routes experiencing an increase of 3.1% according to a DB press interview.[79] While the price for Brent oil increased from €19 per barrel in 2001 to €111 per barrel in May 2008, Brent prices experienced a steep rise—17%—in the period from January to May 2008 alone; the rise has continued well into summer 2008. All across the globe, this cost increase has been particularly damaging for airlines. Figures indicate that in Europe the fuel component increased from 11% in 2003 to 25% or 30% in May 2008, depending on the airlines' cost structures.[80] Due to the rail operators' diversified primary fuel input, with electricity as a secondary energy source, cost increases in energy supply for train operations are likely to be dampened compared to car and plane travel; this is because German base-load electricity used in rail transportation mainly stems from coal and, to some extent, nuclear energy. With respect to aviation, we thus assume in the 2010 base scenario that the financial pressure on low-cost carriers is high. It is assumed to be particularly high on routes opened most recently, i.e. on 23 routes within the observation period, and that these O&Ds will be the first to be closed again by the financially constrained companies. Given the results in the intermodal competition analysis, where a passenger effect of LCA entry of around 7% to 17% for second class passengers is present, we add a complementary 10% increase (in addition to the 5% general increase) of rail passengers on the affected routes.

iii. **Cost reductions in variable and fixed costs:** As a general rule, the prospect of privatizing part of the assets of Deutsche Bahn can be expected to induce cost reductions and productivity gains in all internal cost components (i.e. except fuel costs and, to some extent, access charges) of the company. In addition, the Strategic Rail Research Agenda, published by the European Rail Research Advisory Council, outlines areas of research meant to enhance the economic competitiveness of the products and services rail operators provide, including the application of modularity and standardized interfaces to rolling stock and infrastructure maintenance and the extension of intelligent transport systems. Maximizing capacity while reducing costs is another key factor the European Rail Research Advisory Council mentions; this can be achieved by increasing axle loads, speed, traffic volume, and the loading gauge without expensive investment (ERRAC 2007, p. 23).[81] Similarly, the organization predicts new technologies for staff training and traffic management as well as automated monitoring of infrastructure and associated data processing to aid the development of predictive methods of infrastructure maintenance and better scheduling of track possessions

[78] Based on a market study commissioned by SNCF/DB, a doubling of the share of mode is expected for three O&Ds over the years 1998-2010 (Frankfurt-Paris; Munich-Paris; Stuttgart-Paris). See DB competition report 2008, p.17.

[79] Spiegel Online (May 28, 2008), "Millionen Autofahrer steigen auf Bahn um," http://www.spiegel.de/wirtschaft/0,1518,555926,00.html.

[80] Tanja Wielgoß, "Treibstoffeffizienz im Luftverkehr - Kerosineinsparung als Unternehmens-interesse, Bundesverband der Deutschen Fluggesellschaften," talk delivered in Berlin, May 26, 2008.

[81] ERRAC (2007), Strategic Rail Research Agenda 2020, www.errac.org.

(ERRAC 2007, p. 26). Since the actual monetary gains from these innovations are difficult to quantify, we estimate a general 10% reduction in the costs for drivers and other on-train staff as well as for rolling stock maintenance, following the ERRAC vision that innovative predictive maintenance methodologies for fleet management will be developed using automated remote workshop technologies (ERRAC 2007, p. 25) in the near future. For costs related to ticket sales, we assume a 20% reduction of costs, composed of a 10% decrease due to general efficiencies and a second 10% decrease due to increase via the internet, which DB conservatively projects as rising from 11% of total ticket sales in 2007 to 14% in 2010, and automatic machine sales, which are assumed to increase from 24% to 26% over the same period (Maack 2007, p. 25).[82] Given the strong growth of internet sales between 2002, with €40 million in online revenues, and 2005, with €440 million, we consider a 10% cost reduction until 2010 feasible and likely. In addition, administration and overheads, which are the most important cost drivers with approximately €3.1 per train kilometer according to SDG (2006) estimates, are also expected to decline by 20% by 2010. Although DB and the relevant unions agreed in April 2008 that no lay-offs would occur until 2023 as a result of the company's planned partial privatization,[83] the privatization project is likely to enhance the process of achieving productivity gains by using the workforce more efficiently.

These modifications of the pre-entry profitability analysis are assumed to reflect changes and extrapolate current developments up to the date of the complete opening of long-distance rail passenger transport in 2010.

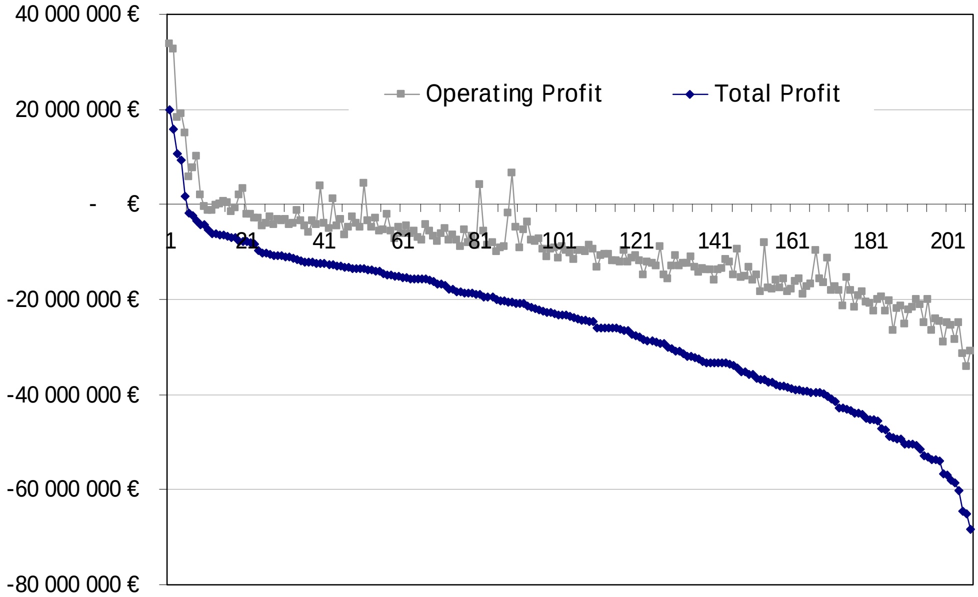
The base scenario in 2010 relies on the projected changes and assumptions described above, including an increase in total passenger numbers by 5% on all routes and on an additional 10% if LCA entry occurred over the observation period, with the underlying assumption that due to high kerosene costs low-cost airlines are most likely to mainly stop services on routes that have most recently been established. Furthermore, we envision a reduction in variable costs (drivers and other on-train staff) by 10% and subsequent reduction in fixed costs: rolling stock maintenance by 10%, administration and overheads and ticket sales by 20%.

In fact, total profits are generally up compared to the ex-ante scenario, but only one additional, domestic O&D is able to reach break-even point. In the framework of operational profit, the number of profitable O&Ds remains similar to the pre-entry scenario. The following graph shows the overall ranking:

[82] Thomas Maack, "Deutsche Bahn AG- Mobilitätsdienstleister im Norden," talk delivered at the 1st Salzgitter-Forum Mobilität, 2007.

[83] See also related article in SpiegelOnline (2008), Bahn-Privatisierung soll bis 2023 keine Arbeitsplätze kosten, http://www.spiegel.de/wirtschaft/0,1518,549844,00.html.

Figure 9: Operating profit and total profit in the base scenario 2010



Source: ESMT CA

The base scenario for 2010 relies on realistic but optimistic modifications of the status quo profitability scenario, with regards to both revenues and costs. However, our analysis suggests that entry remains rather unlikely for the vast majority of O&Ds even under more favorable conditions than in 2007. Up to now, we have excluded any quantification of the impact of the Third Railway Package and its regulations; we have also not adapted the revenues and costs model to the specific configurations and cost advantages of different sorts of potential entrants. The following two sections provide that differentiation and discuss the main results of the profitability analysis.

Entry analysis 2010: Strategies

Entry strategies in long-distance rail passenger transport may take various shapes. We have identified the three most likely entry scenarios, given both prior experience in Germany and other countries and the current competitive situation in the larger context of European integration of transport systems.[84] Conceptually, the following categories can be established: With respect to technology and design of the rolling stock, one can distinguish between

[84] Our scenario selection is consistent with the likely forms of entry identified by the Monopolkommission (2007: 53).

- a high-speed train similar to the ICE or the TGV whose speed can easily exceed 250 km/h, and which contains technology for hermetically closing the passenger space to compensate for pressure difference in tunnels at high velocity, and
- an intercity train similar to the conventional German IC-EC trains or the intercity trains circulating in other countries like the UK, the Netherlands, and Denmark that cannot exceed 250 km/h in speed and is generally based on less sophisticated technology; one prominent example of that technology would be the newly developed Railjet, of which the Austrian rail company ÖBB purchased 23 trains.[85]

The major difference between the two scenarios is the amount of capital required for the initial capital investment. While intercity trains and their technology can even be rented from commercially operating firms, high-speed trains like the ICE or TGV are manufactured in a tailored way for specific technological requirements and have to be purchased in specified groups from the individual producers.

Thalys would be a prototypical high-speed train operating on German tracks, whereas the InterConnex trains circulating between Leipzig and Warnemünde would more closely correspond to the intercity type of technology.

For simplicity's sake, we refer to the technology-driven differences in the scenarios as “top-down” and “bottom-up,” since the former needs a high-profile investment strategy (see NTV above) while the latter can be launched with existing rolling stock from on-going operations on other O&Ds or relatively easy rentals.

As a second way to distinguish between entry strategies, the history and corporate structure of the entrant can be taken into account. Again, we suggest two alternatives:

- first, entry can occur as the strategy of an incumbent rail operator from a neighboring territory to expand its reach and network services into German territory, which we call “incumbent expansion;”
- second, a newly founded venture or internationally operating rail company may decide to launch services on German tracks, irrespective of prior presence in the German or neighboring rail markets.

Both scenarios are possible and not unlikely for the German case. The first scenario may occur if e.g. the Danish railway company Danske Statsbaner decides to extend its routes to Hamburg or Berlin, whereas the second scenario is matched by the Nuovi Trasporti Viaggiatori venture that will be operational by 2011 on the Italian network.

[85] See section 5.4: R&C model: Structure and assumptions (page 82) for a more detailed description of the Railjet.

In the base scenario for 2010, we have included transfer and intermediate passengers in our revenues figure. However, the regulatory conditions are not yet clear and may be altered after implementation of the Third Railway Package. In this analysis, we will focus on two important legislative orders and interventions:

- first, an expanding incumbent from a neighboring territory may or may not have the right to carry transfer passengers and intermediate passengers to the same extent as Deutsche Bahn (cabotage), so the revenue figures have to be adjusted accordingly;
- second, the public service levy that is one of the major elements outlined in the package may be implemented and have a severe impact by inducing additional costs for stopping in the territory of a local rail transport provider.[86]

If the technology-driven classification and the corporate-structure distinction are combined in a matrix, a pattern of four dominant strategies emerges, as represented in the following figure. The top-down and bottom-up approaches are depicted on the horizontal axis, while the corporate structure is depicted on the vertical axis.

Figure 10: Entry scenarios

	Top-down	**Bottom-up**
Incumbent expansion	High-Speed Rail from neighboring territory	Considered unlikely
Independent entrant	Independent HSR operator	Intercity operator

Source: ESMT CA

Starting anti-clockwise from the top-left quadrant in figure 10, the following scenarios emerge:

i. IIncumbent expansion/top-down

ii. IIndependent entrant/top-down

iii. Independent entrant/bottom-up

[86] In Paragraph 12 of Directive 2007/58/EC, the following description of a future public service levy is provided: "The assessment of whether the economic equilibrium of the public service contract could be compromised should take into account predetermined criteria such as the impact on the profitability of any services which are included in a public service contract, including consequential impacts on the net cost to the competent public authority that awarded the contract, passenger demand, ticket pricing, ticketing arrangements, location and number of stops on both sides of the border and timing and frequency of the proposed new service. Respecting such an assessment and the decision of the relevant regulatory body, Member States might authorise, modify or deny the right of access for the international passenger service sought, including the levying of a charge on the operator of a new international passenger service, in line with the economic analysis and in accordance with Community law and the principles of equality and non-discrimination."

iv. Incumbent expansion/bottom-up

Among scenarios i to iv, the last scenario can be considered unlikely for one major reason. Historically, bi- or trinational intercity services have existed for many decades under the EuroCity brand. The operations of these trains have been based on mutual agreements about profit-sharing and long-term contracts between incumbent rail operators. Hence, this segment of the market is already covered by the sector's institutional arrangements.

Regarding incumbent expansion vs. entry by an independent entrant, we can also imagine variations of these two types of entry. For example, Thalys is an independent company with autonomous decision-making powers and strategies but owned by several incumbent rail operators. It thus has a combination of financial backing and managerial discretion that would classify it most reasonably in the middle. Similarly, an incumbent rail operator can individually found a low-cost subsidiary and launch its operations on the German market. However, in the following analysis we will concentrate on the four cases outlined above, in order to more efficiently distinguish the contestability of given O&Ds according to the most orthogonal entry strategies. The four scenarios will be examined carefully, and conclusions on entry into the long-distance passenger rail segment in Germany will be drawn for different potential entrants described in detail in the following section.

Entry analysis 2010 - Evaluation of entry scenarios

As outlined, competition may emerge in the form of incumbents entering from neighboring countries. Similarly, smaller operators and independent entrants could potentially target point-to-point services, either as operators of high-speed rail or in the less cost-intensive (and therefore less risky) intercity segment, with conventional trains speeding up to 200-250 km/h. We will use the constructed R&C model to simulate these scenarios and draw preliminary conclusions from its findings. As previously indicated, the scenarios are built without taking strategic interaction or sequential gaming between entrant and incumbent into account, on the assumption that any O&D specific competition will drive profitability down even more.

Scenario I: Incumbent expansion/top-down with cabotage

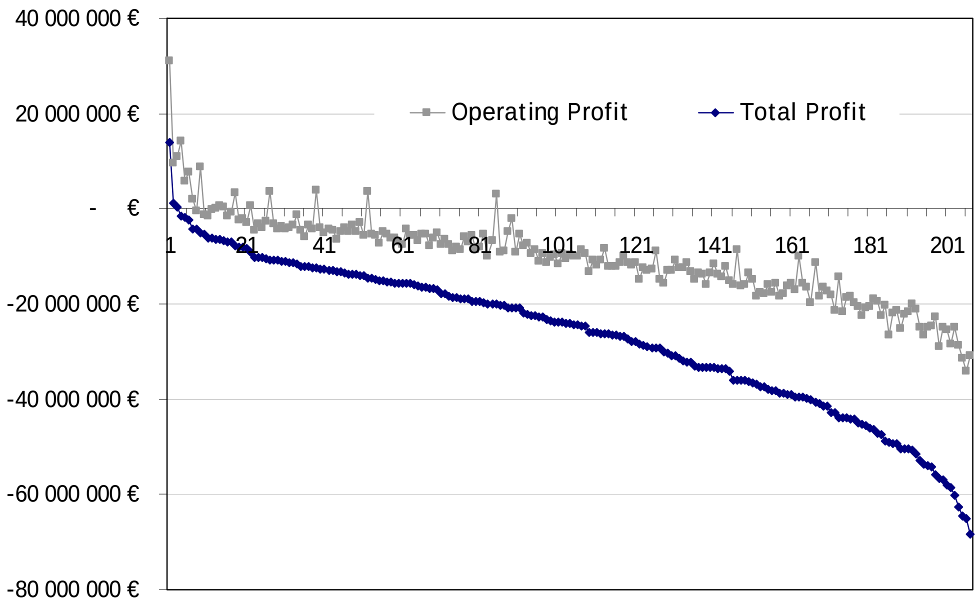
An incumbent rail company from a neighboring country is allowed to competitively enter under the framework suggested in the Third Railway Package. The incumbent is assumed to be operating high-speed rail with cutting-edge technology upon its own network and with the financial muscle to expand its operations into Germany from neighboring territory.

The following adaptations to the base scenario in 2010 have been performed:

- The existence of a public service levy imposed on services operating in the territory of regional rail service providers on the German side is added to the variable costs; here we assume that only O&Ds with intermediate stops with an average of less than 50 km between stops are affected, following the boundaries of a public service rail provider as defined in the regulation of these services.
- The possibility of cabotage for the scenario of incumbent expansion, i.e. the possibility of transporting intermediate passengers on German territory, is included; however, the additional revenues that would result from transporting transfer passengers cannot be added, because the incumbent is not able to rely on the DB network.
- All assumptions on the reduction of variable and fixed costs are maintained from the base scenario, assuming that an incumbent exhibits a pattern of corporate change and evolution similar to that of DB.

The analysis yields the following results, ranked by descending total profit:

Figure 11: Operating profit and total profit of O&D universe in scenario Ia



Source: ESMT CA

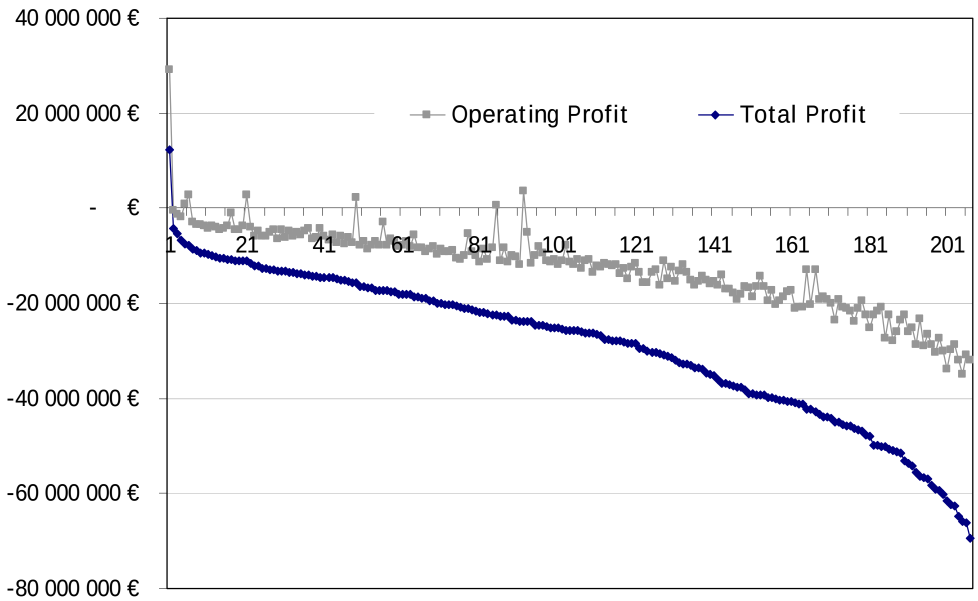
In the ranks of the O&Ds that break even, the number has been slightly reduced, compared to the base scenario 2010, due to the removal of the transfer passengers. Three domestic O&Ds are still profitable with respect to total profits, all of them are domestic. Minor shifts related to the public service operator levy are only evident in the lower ranks, especially on domestic O&Ds with more frequent stops and high passenger numbers. Given the construction of the admittedly uncertain concept and implementation of the public service operator levy, its impact on high-speed passenger transport services can be understood as limited, since by their very structure most O&Ds are not affected in this manner. In sum, this scenario can be interpreted as a confirmation of the base scenario 2010, where incumbents entering from neighboring countries would have to reject any expansion into German territory on profitability grounds, similar to DB not being able to offer cost-covering services to destinations abroad. The cash-generating routes in the German network are identified as located in German territory, which makes cross-border expansion less likely.

Scenario I: Incumbent expansion/top-down *without* cabotage
As in the previous scenario, an incumbent rail operator from a neighboring country is allowed to competitively enter under the framework suggested in the Third Railway Package. The incumbent is again assumed to be operating high-speed rail with cutting-edge technology upon its own network and with a financial ability to expand operations into Germany from neighboring territory. However, the following modifications to the previous scenario have been implemented:

- The possibility of cabotage for the scenario of incumbent expansion, i.e. the possibility of transporting intermediate passengers on German territory, is removed, i.e. the incumbent is not allowed to carry any intermediate or transfer passengers on German territory, but can only transport them from the origin of the trip into its own network. As explained above, this assumption is highly implausible given the strong bias of the EC in favor of cabotage, but it nevertheless needs to be discussed to provide the full spectrum of possibilities.
- As a consequence of the regulatory denial of cabotage, the public service levy cannot be imposed on the new services operating in the territory of regional rail transport providers, because the trains are not allowed to carry this passenger segment anyway.
- All other assumptions regarding the reduction of variable and fixed costs are, however, similar to the previous scenario.

The simulation yields the following result:

Figure 12: Operating profit and total profit of O&D universe in scenario I without cabotage



Source: ESMT CA

The graph indicates that profitability generally decreases compared to the scenario with cabotage. In total, 7 O&Ds break even with respect to operating profit, but only one service can achieve a positive net result when capital costs and fixed costs are integrated. All of the routes that have positive operating profits are located exclusively within German boundaries. In other words, according to our estimates not a single international line is able to yield enough revenues to cover costs. Given that this scenario is meant to evaluate the likelihood of entry of an incumbent expansion, international entry can in general be considered highly unlikely, but it is even more unlikely if entrants are restricted to operating their services without cabotage.

This result also confirms the importance of methodologically understanding and empirically evaluating long-distance passenger rail transport as driven by positive network externalities. Any analysis that focuses exclusively on a comparison between origin and destination fails to integrate the competitive advantage that meshed rail networks offer both customers and operators. Even if Seabright mainly refers to transfer passengers at the end points of each O&D in his model of the negative opportunity costs of network operators (a model discussed at length in the literature review), it can also here serve as an additional explanation of why the market share of entrants in the passenger rail sector may be lower than expected: intermediate passengers are to a large extent responsible for the profitability of routes, and any liberalization effort without cabotage is highly likely to fail due to the lack of sufficient revenues.

Scenario II: Independent entrant/top-down

This scenario is based on the “cream-skimming” strategy an independent operator may pursue when entering the German long-distance passenger rail market. Although no company has expressed interest in entering the German market in 2010 (unlike Nuovi Trasporti Viaggiatori in Italy), we assume that entry can potentially take place despite all the technical hurdles and regulatory barriers that may delay it. We furthermore characterize the entrant as capable of operating high-speed rail with cutting-edge technology irrespective of any prior experience in the German network.

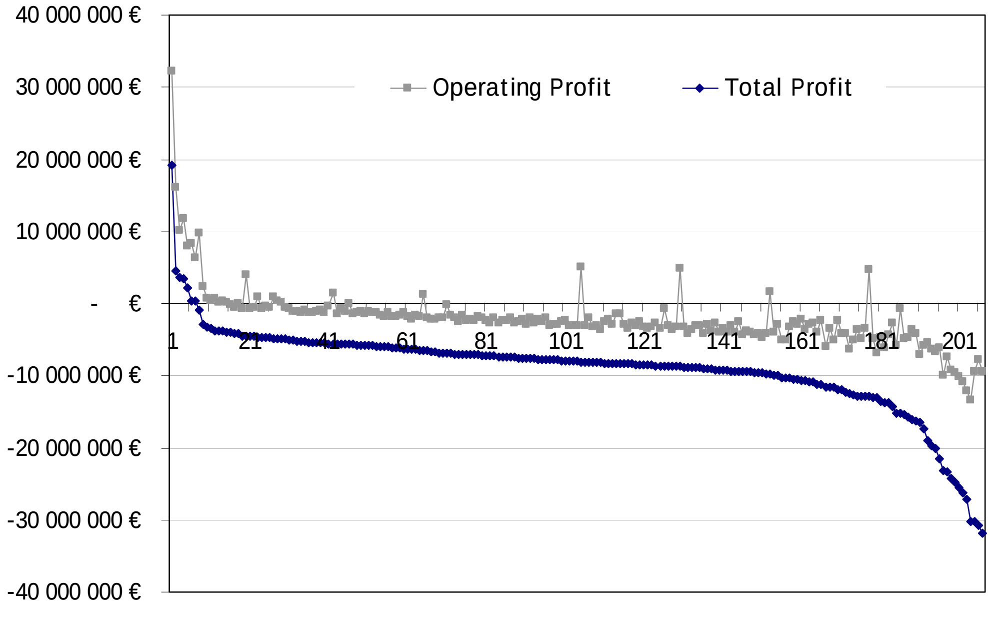
To mirror the alternative strategy set of an independent entrant, the following modifications to the base scenario in 2010 have been undertaken:

- The “cream-skimming” strategy of an independent entrant implies that the frequency of trains is reduced to correspond to the actual load factor experienced on an O&D; this change also reflects the lack of incumbent operators able to satisfy their hub-and-spoke system by maintaining high frequencies on unprofitable routes serving as spoke services for the more profitable O&Ds. A substantial decrease of capital costs is the logical consequence of this change. However, the model does not allow for integrating negative side effects like the Mohring effect but assumes a constant number of travelers.
- An independent entrant may base its entry calculation on substantially reduced variable costs for drivers and on-train staff and for fixed costs related to ticketing and administration and overheads. Here we assume that costs vis-à-vis the estimates used in the pre-entry scenario are cut by 50%;[87] in contrast, fuel costs will be higher by 20% for an independent entrant because of the lack of long-term bilateral contracts with energy suppliers. In this manner, we cautiously extrapolate the electricity price trends over the last five years into 2010.
- The possibility of cabotage for the scenario of independent entry, i.e. the possibility of transporting intermediate and transfer passengers, is included; however, the additional revenues that would result from transporting transfer passengers cannot be added, because the independent entrant may only serve one specific O&D.
- The public service levy imposed on services operating in the territory of regional rail service providers both on the German side and on the side of other countries is added to the variable costs; here we assume (as in scenario Ia) that only O&Ds with intermediate stops with an average of less than 50 km between stops are affected, following the boundaries of a public service rail provider as defined in the regulation of these services. However, here we only take the O&Ds with ICE stops less than 50 km apart into account.

[87] This stark assumption does not imply that these cost savings have to be considered realistic or could actually be achieved by an operator; they rather correspond to a theoretical upper limit broadly interpreting the “reasonable but optimistic” approach in favor of an independent entrant.

The model generates the following results:

Figure 13: Operating profit and total profit of O&D universe in scenario II



Source: ESMT CA

The graph shows that the most apparent result of this scenario is a significant reduction in capital costs; they have actually almost halved. This is related to the reduction of services on several routes, resulting in substantially lower capital costs to cover the expenses for rolling stock.[88] Similarly, the reduction of frequencies leads to substantial cost-savings in variable costs and access charges, which are based on the number of trains circulating on an O&D. These effects lead to a sharp increase of the average profitability level in both indicators. However, the alleviations are not sufficient to shift more than 7 O&Ds beyond the break-even point. Two of those O&Ds are international and benefit in terms of passenger numbers from the highly profitable inner-German connections. When focusing on operating costs, a total of 27 O&Ds are estimated to be profitable under the given assumptions. Of those, 13 are international and 14 domestic. These O&Ds are likely to be particularly affected by threats from aviation, especially low-cost carriers, even if kerosene price increases persist. For example, on one route 18 low-cost flights per week were offered in 2006; on another route that equally shows operational profits, 5 flights by low-cost carriers were operated weekly, in addition to the regular flights by the incumbent airlines. The threat from airlines may thus be an additional hurdle deterring entry.

[88] Under the "reasonable but optimistic" assumptions for the 2010 scenarios, we assume that the capital costs for an independent entrant are similar to the ones borne by an incumbent rail operator. However, it would also be plausible to expect entrants to have higher capital costs due to lack of scale in leasing and purchase.

In sum, it has to be stated that the total profit figures, as the chief indicator for the long-term viability of passenger transport links, remain negative for the bulk of the examined O&Ds, and only a few inner-German routes (with extensions in neighboring countries) move into the profit zone. These findings would be even more negative if the assumptions regarding capital costs were modified from the base case in order to reflect the different financial constraints that entrants may face: we would most likely have to expect entrants to have higher capital costs due to lack of scale in leasing and purchase of rolling stock and because they cannot optimize the use of their rolling stock.

Scenario III: Independent entrant/bottom-up

There are already some operators corresponding to this entry scenario offering services in Germany, including InterConnex and Vogtlandbahn. Given that quality competition with the high-speed, high-quality trains of Deutsche Bahn is not as likely as it is in Italy, where NTV may successfully compete with Trenitalia by offering more luxurious, punctual, and reliable services, a bottom-up entry from 2010 seems a priori more plausible than the emergence of a top-down entrant. We again assume that the potential independent operator will pursue a “cream-skimming” strategy when entering the German long-distance passenger rail market, but that the operator will focus on the traditional intercity long-distance services. This focus induces the following changes to the scenario:

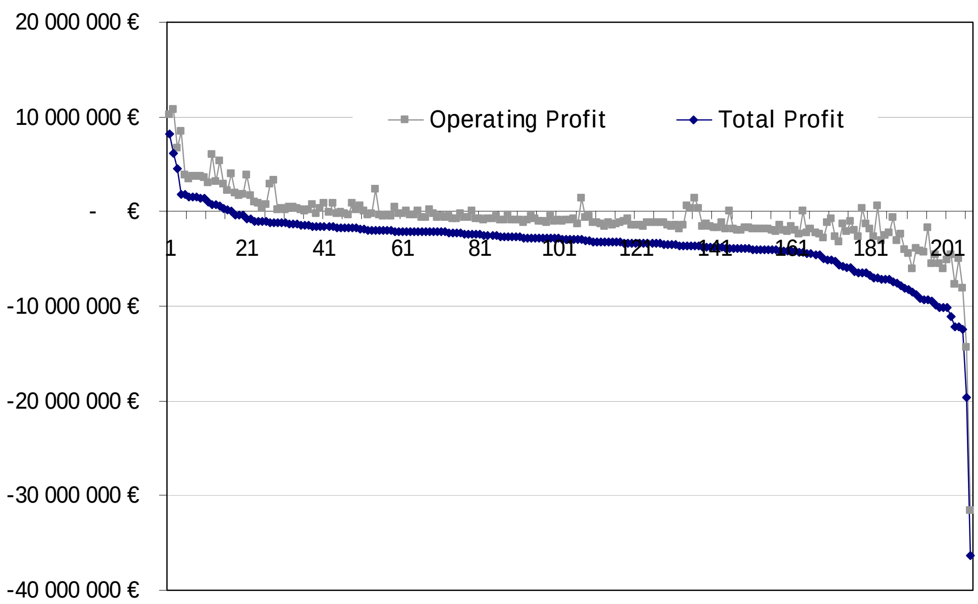
- For domestic O&Ds, the revenue figures distinguish ICE and IC services; here we assume that a bottom-up entrant is only interested and capable of taking over the slower intercity connections.
- For the revenue figures of international O&Ds, no data distinction between ICE and intercity services can be made; in order to tackle this problem, we differentiate according to observed frequencies of services of both ICE and IC trains, then allocating the passengers accordingly; this simplification does not take into account that price levels and therefore revenue figures may be substantially lower for intercity services, thereby overestimating the revenues of individual O&Ds with a bottom-up entrant. In addition, we do not assume that strategic interaction between incumbents focusing on high-speed rail exceeding 200 km/h and providers of slower services takes place, since they target different customer segments.
- The “cream-skimming” strategy of an independent entrant implies that the frequency of intercity trains is reduced to correspond to the actual load factor experienced on an O&D; however, the model does not allow for integrating negative side effects like the Mohring effect but assumes a constant number of travelers on the entrant’s trains.
- As in scenario II, an independent entrant may base its entry calculation on substantially reduced variable costs for drivers and on-train staff and for fixed costs related to ticketing and administration and overheads; here we assume

that costs vis-à-vis the estimates used in the pre-entry scenario are cut by 50%. In contrast, fuel costs will be higher by 20% for an independent entrant because of the lack of long-term bilateral contracts with energy suppliers. In this way we again cautiously extrapolate the electricity price trends over the last five years into 2010.

- The possibility of cabotage for the scenario of independent entry, i.e. the possibility of transporting intermediate and transfer passengers, is included; however, the additional revenues that would result from transporting transfer passengers cannot be added, because the independent entrant may only serve one specific O&D.
- The public service levy imposed on services operating in the territory of regional rail service providers both on the German side and on the side of other countries is added to the variable costs; here we assume (as in scenario Ia) that only O&Ds with intermediate stops with an average of less than 50 km between stops are affected, following the boundaries of a public service rail provider as defined in the regulation of these services. We only add the PSO supplement to the subsample of O&Ds with IC stops less than 50 km apart.

The ranking of total profits of individual O&Ds for scenario III is depicted in the following graph.

Figure 14: Operating profit and total profit of O&D universe in scenario III



Source: ESMT CA.

The total profit figures indicate that 16 O&Ds lie beyond the break-even point, including longer, international lines. When it comes to operating profit, 59 O&Ds have positive results. This outcome is indeed in line with the Monopolkommission's vision of entry on longer O&Ds, where providers of lengthier and slower low-cost services such as the InterConnex or Vogtlandbahn trains may target the less time-sensitive traveler segment, or where operators active in regional transportation under long-term contracts with municipalities may be capable of extending their services from the local environment to longer trips. The profitable lines are actually characterized by a fairly high number of intermediate stops. However, if stops become too frequent, the PSO levy imposes a burden on operators that renders the O&D fully unprofitable, if high intermediate passenger numbers are assumed.

The graph clearly shows that the total profits of most of the O&Ds are sufficiently close to the break-even point for a private venture to be launched. In addition, the impact of the Mohring effect may be reduced compared to scenario II, because the convenience of a high frequency of trains may be less pronounced for cost-sensitive travelers, in contrast to the status of more time-sensitive travelers as the preferred target group in the previous scenario. However, scenario III has its limitations, namely the lack of quantification and the exclusion of slot scarcity from the model.

In a review of scenarios I to III, scenario III emerges as the most likely entry scenario when profit maximization is taken as the ultimate objective of any new competitor. It may thus be worthwhile to explore the facets of scenario III under different regulatory conditions. Even though the case discussed above—including the inclusion of intermediate passengers and exclusion of transfer passengers—seems the most likely regulatory scenario, alternative regulatory trajectories cannot be fully excluded.

As a first variation, we omit the PSO levy. Given that the levy affects only a limited number of O&Ds—even in intercity services less than 20% of the O&Ds have stops within less than 50 km, averaged over total distance—we encounter no changes in the composition of the group of O&Ds that have positive total profits. However, the sub-sample size changes with respect to operating profits. Four additional O&Ds have shifted into profitability, increasing the total number to 62. Even beyond profitability, substantial changes can be observed. For example, one O&S that was heavily affected by the levy due to high passenger numbers, climbed from the last position to a significantly better level, albeit it still remains loss-making. The limitations of our knowledge about the implementation of the levy make it difficult to offer a conclusive judgment regarding actual impact on profitability, but preliminary insights based on the model indicate that a levy would indeed have a detrimental effect on entry conditions for new intercity operators, especially those close to the critical point of breaking even.

As a second variation of scenario III, we tackle cabotage. The reasoning involved in including intermediate passengers is based on the European Commission's unambiguous promotion of cabotage as part of the future opening up of long-distance passenger transport. Intercity trains cannot compete with high-speed trains and thus have to offer other benefits like lower prices and stops in less demographically important agglomerations. However, if cabotage were not allowed—maybe due to some rise of protectionism before 2010—the model would yield the following results: not a single O&D of the sample would actually reach the profit zone in terms of total profits, while only six O&Ds would be able to yield positive operational profits. Adding the PSO levy to the results does not alter these findings. We can conclude that the absence of cabotage would basically eliminate the emergence of entry in the intercity segment.

The third variation involves our postulation in scenario III of an exclusion of transfer passengers and our assumption of competition, not co-operation, between the entrant and the existing incumbent. In this alternative world, joint ticketing and "hop-on-the-next-train" regulations could be imposed by European authorities or national regulators on intercity services. In this variation, any O&D could be complemented by existing transfer passengers on IC routes, corresponding to the calculation of transfer passengers as outlined in section 5.4: R&C model – Structure and assumptions (page 82), but limited to intercity passengers. This scenario thus closely corresponds to the base scenario 2010 without the integration of ICE passengers.[89] A change on a purely domestic level increases the number of O&Ds with a positive total profit from 16 to 19 (similar results are present for PSO levy addition and without PSO levy) and the size of routes with positive operating profit from 59 to 61 with the levy and to 66 without the levy. If international transfer passengers are included, the numbers rise to 20 O&Ds having overall positive total profits with and without PSO levy, 64 despite the PSO levy, and 69 without the levy.

As expected, regulatory intervention in favor of network integration between intercity operators would have a positive effect not only on load factors and passenger convenience, but also on overall profitability figures, which again points to the importance of network externalities in the rail sector.

Conclusions of the scenario analysis

After the panel data analysis, the R&C model is the second pillar on which we base our assessment of the competitive situation that long-distance passenger rail faces currently and will face in the future.

In a first step, the analysis determines the pre-entry profitability as a status quo scenario. Based on the R&C model, we find an overall low level of profitability with respect to total profit. Of the total of the 207 O&Ds, only four break even, none of which are international routes. With respect to operating profits, we find 18 O&Ds to be profitable. International O&Ds have a share of slightly less than a

[89] We simulate this regulatory intervention by adding the amount of intercity transfer passengers to the initial scenario configuration, taking the overall ratio of IC versus ICE frequencies as an average and subtracting the percentage of ICE passengers from total transfer passenger figures for each O&D.

third, with 5 observations. International routes are therefore underrepresented in the group of profitable O&Ds (representation in the overall sample is 62%). Within the profitable international routes, most of the revenue is driven by domestic intermediate passengers.

To project developments at the start of the Third Railway Package, we then develop a base scenario for the year 2010. It relies on assumptions about future cost and revenue figures. These assumptions are considered reasonable, but optimistic; they sketch a vision of the future with minor but not unimportant technological developments, a realistic rise in passenger numbers, and realizable increases in overall business efficiency. In comparison to the status quo scenario, only one additional O&D becomes profitable with respect to total profitability and no further O&D becomes profitable with respect to operating profitability.

Departing from the base scenario 2010, we further analyze profitabilities of various entry strategies. In a first scenario, we model an incumbent's expansion with cabotage and ICE-equivalent technology from a neighboring territory. This scenario can be interpreted as a confirmation of the base scenario 2010 but allows only three O&Ds to become profitable with respect to total profitability, due to the removal of transfer passengers. Incumbents entering from neighboring countries would have to reject any expansion into German territory on profitability grounds. The cash-generating routes in the German network are identified as located within German territory, which makes cross-border expansion less likely. As a variation, we then model an incumbent's high-speed rail expansion without cabotage. There the O&D-specific profitability is significantly lower compared to the scenario with cabotage. An incumbent expansion strategy thus seems even less likely in such a scenario, indicating the importance of network effects and the risks associated with any legal or strategic limitations imposed on an entrant's potential to attract intermediate or transfer passengers.

Under strong assumptions on cost savings and efficient scheduling, an independent entrant with ICE-equivalent technology is then simulated in a further scenario. While profitability estimates shift upwards, total profitability remains negative for the bulk of the examined O&Ds and only a few routes move into the profit zone, all of them domestic (albeit with extensions in neighboring countries).

The only reasonably likely scenario concerns an independent entrant with a bottom-up strategy, for example a regional operator, moving with intercity-equivalent rolling stock technology into the German long-distance market. In this scenario, the total profit figures show that 16 O&Ds lie beyond the break-even point, including longer and international routes. Overall, most of the O&Ds are close to the break-even point, indicating a relatively high entry probability.

Variations of the scenario show that if cabotage is forbidden on the intercity level, all routes are below profitability levels with respect to total profits and only a few routes would break even in operational profits. By contrast, if joint ticketing and “hop on the next train” regulations were imposed by European authorities or national regulators on intercity services and any O&D could be complemented by existing transfer passengers on complementary IC routes, the number of O&Ds with a positive total profit would be increased from 16 to 19 on domestic territory and to 20 if international transfer passengers were included. The amount of routes with positive operating profit would rise from 59 to at least 61 domestically, even with a public service levy, and to at least 64 operationally profitable O&Ds with international transfer passengers.

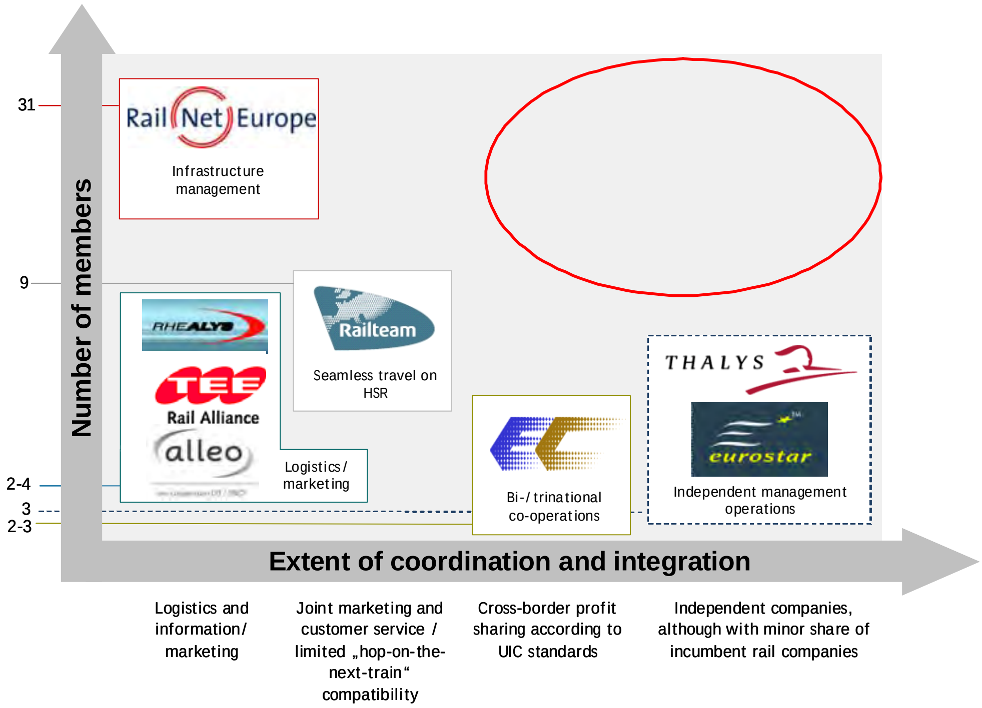
In sum, the scenario analysis indicates that on grounds of total profitability, entry—especially on international routes—is only likely in the bottom-up intercity segment of the market.

6.
Final assessment and the role of alliances in the railway sector

Given the results of potential entry into long-distance passenger transport in the base scenario 2010 and the subsequent scenarios simulating incumbent expansion and independent entry into high-speed rail, an evaluation of alliances may be based on the overall negative outlook for entry given the estimated levels of profitability. In fact, while the high capital costs, combined with high risk and uncertainty on regulatory conditions and passenger numbers, prevent entry within the high-speed segment of the market, our scenario results suggest that effective and profitable entry in larger numbers is likely to occur—if at all—only within the intercity, i.e. low-speed segment of long-distance passenger transport. Such profitability is enhanced by regulation imposing joint ticketing and "hop on the next train" policies, which might also be a feature of alliances between incumbent operators. In the intercity segment, mutual agreements between incumbent operators on profit-sharing have already existed for many years, and some other forms of alliances and co-operations are either envisaged or have already been implemented.

An ad-hoc analysis of the spectrum of existing co-operations among European incumbents characterizes them by the number of members on the vertical axis and the extent of co-operation on the horizontal axis.

Figure 15: Co-operations in the European high-speed rail market



Source: ESMT CA

The top right corner of the graph in figure 15, depicted by a red ellipse, is empty because not a single type of alliance has the depth and reach (in terms of participants) to be considered a single operational entity. As our scenario analysis has shown the importance of network effects for overall profitability such a (non-existent) type of joint venture could have benefits in tackling competitive threats from aviation. However, a co-operation of that kind could also have anti-competitive effects in deterring entry from potential competitors. Any such co-operation would have to be carefully examined.

The empirical results derived in our panel data analysis and scenario analysis add some important elements to our assessment.

First, we find that in a counterfactual situation without alliances the likelihood of strong intramodal competition emerging is low. This is particularly the case for international O&Ds, where based on current revenue figures and plausible cost assumptions profitability cannot be expected. Accordingly, drastic changes are required to gain profitability. Within such a counterfactual situation, alliances limited to O&Ds with low likelihood of intra-modal entry will most likely have no anti-competitive effects.

Second, our simulation results suggest that the highest probability for intra-modal competition to emerge is entry by independent IC operators. This entry is most likely to occur on O&Ds with a sufficient number of interim stops and a regulative environment allowing transfer passengers to change operators to some degree. Asymmetric liberalization may result in strong country disparities with respect to such competition, as those independent operators are strongly dependant on integration into existing networks and are vulnerable to a public procurement levy. Insofar as alliances between incumbent operators are aimed at excluding such forms of competition by low tech/ independent operators, our analysis suggests that significant efficiency gains are required to counterbalance the potential negative effects.

Third, our analysis suggests a necessity of more broadly integrating competition by other transportation modes into a competitive assessment of alliances. From both a statistical and economic perspective, the negative effects of entry of LCAs on passenger numbers are significant: competition by air transportation places a significant restrain on rail operators. Most interestingly, our results indicate that at least on domestic routes, where rail operators have more leeway to adjust prices, intermodal competition does affect average rail prices despite the overall price rigidity of an open network structure.

With respect to economic benefits, current efforts by incumbent rail operators to offer joint ticketing and “hop-on-the-next-train” options to some extent mirror the European Commission’s effort to create a joint and transparent market and deliver a fair share to customers associated with such alliances. Deeper alliances may allow further efficiencies related to pricing, eliminating double-marginalization and introducing higher pricing flexibility on international routes. The case of airline alliances, as outlined in the literature overview, could hint that co-operations may lead to lower prices and better customer service. Whether this is the case for railways remains untested.

Appendix 1
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Appendix 2
Panel data analysis

A2.1
Econometric issues

The major problem facing panel data analysis of this kind is that of endogeneity: the possibility that the error term is correlated with our right-hand-side variables. We deal with two manifestations of this—a generic problem of unobserved heterogeneity and the more specific problem of sample selection arising from strategic LCA entry. We treat each of these in turn.

Unobserved heterogeneity: The generic problem

The major challenge in panel data estimation of this sort is the presence of unobserved O&D effects that may have a bearing on the outcome but are not observed by the researcher. To see this, consider the following decomposition of the error term from equation (1) of the main text:

$$\varepsilon_{it} = c_i + u_{it} \qquad (2)$$

Where c_i is a measure of route-specific, time-invariant characteristics unobserved to the researcher but which have a bearing on the outcome. Substituting equation (2) in equation (1), we obtain:

$$y_{it} = \delta LCA_{it} + \gamma \mathbf{z}_{it} + \lambda_t + c_i + u_{it} \qquad (3)$$

To what extent c_i affects our estimates depends on whether it is correlated with our explanatory variables or not. When it is *not* but when the error term is serially correlated, pooled ordinary least squares (OLS) applied to equation (1) will result in biased standard errors (i.e. we are not sure whether the statistically significant results we observe are truly significant). When c_i is correlated with any of our explanatory variables, our estimates of δ will be biased.

In our case, tests suggest that the error term is serially correlated. In this case random effects (RE) estimation applied to equation (3) is preferred to pooled OLS. Since many of our explanatory variables do not vary substantially over time, FE can result in imprecise estimates. RE are preferred to FE when c_i is uncorrelated with the explanatory variables. With large samples such as ours, this tends to be the case, and with our data a Hausman specification test suggests that RE is the more appropriate estimation technique.

A2.2
Unobserved heterogeneity: The specific problem

To see the endogeneity problem related to strategic LCA entry more formally, let us abstract altogether from equations (2) and (3) and consider instead the following extension to equation (1):[90]

$$LCA_{it} = \pi q_{it} + \lambda_t + v_{it} \tag{4}$$

q_{it} is a vector of exogenous regressors. Endogeneity of LCA_{it} arises when v_{it} is correlated with the error term ε_{it} in equation (1).

In addition to the difficulty in finding a time-varying instrument described in the main text, our particular problem is further complicated by the fact that we have what is called a binary endogenous regressor, i.e. the variable whose endogeneity may be a source of concern is LCA_{it} , and it takes values equal to either 0 or 1. Two stage least squares (2SLS), the standard IV estimation procedure, is consistent in this case, but it is typically inefficient. A control function is typically more efficient and more precise. It is also consistent, provided equation (4) is correctly specified.

The control function approach we use here entails estimating the following model using maximum likelihood (ML):[91]

$$y_{it} = \delta LCA_{it} + \gamma \mathbf{z}_{it} + \lambda_t + \varepsilon_{it}$$

$$LCA_{it} = \phi x_{it} + \lambda_t + v_{it}$$

90 We follow the NBER Summer School Lecture Notes of Wooldridge and Imben (2007).

91 This model is derived in Maddal, G.S. (1983), p. 122.

where x_{it} contains our excluded instruments (i.e. the LCA network measure alluded to above) and the decision for an LCA to enter and operate is made according to the rule:

$$LCA_{it} = \begin{cases} 1, & if \quad LCA*_{it} > 0 \\ 0, & otherwise \end{cases}$$

The control function approach basically allows for correlation between the error terms in equations (1) and (4): ε_{it} and v_{it} assumed to be are bivariate normal with a mean zero and covariance matrix:

$$\begin{bmatrix} \sigma & \rho \\ \rho & 1 \end{bmatrix}$$

Our control function estimates for the DB prices model confirms that such correlation exists (i.e. $\rho > 0$) and this confirms that selection bias may be a source of concern in our price estimates.

A2.3
Data

In order to examine the intermodal competition of railways, we constructed a new O&D-level database covering the overwhelming majority of DB's passenger rail activity within Germany and from Germany to some neighboring countries for the January 2006–April 2008 period. This comprehensive database was created by a complex process of matching information from initially various data sets.

Railway traffic and ticket prices were provided by Deutsche Bahn. The passenger railway data comprises 28 cities covering 207 routes within and from Germany, whereby the international O&D have destinations in Austria, Belgium, Denmark, France, the Netherlands, and Switzerland. The O&Ds comprise 77 domestic and 130 cross-border routes.

The number of passengers and the ticket prices are grouped by first and second classes, whereby the domestic railway data in the raw data was classified by train types (ICE or EC/IC) and the international railway data by various price categories. The total passenger kilometers were provided by DB for domestic routes alone; a comparable variable for international routes was constructed using the length of the fastest railroad connection (see 1.2).

The information on the entry date and the duration of operation on the routes of interest were obtained upon repeated enquiries from individual LCAs. In this sample, we observed 33 entries of 9 airlines from January 2006 until October 2007 (appendix A2.3, table 8).[92] This amounts to 12.3% and 22.1% of the total international and domestic O&Ds having experienced LCA entry over the sample period.

Airline traffic and capacity data were retrieved from a database compiled by the Association of German Airports (ADV). Updated monthly, the database offers detailed information on airline operations, including passenger numbers, passenger kilometers, load factor, available number of seats, and total flights, and has the advantage of covering an extensive sample of O&Ds. This route-based data cover the overwhelming majority of scheduled flights within and from/to Germany. Our complete airline dataset contans information on German domestic and cross-border European flights operated on 378 connections between 28 O&Ds during the observed period.

Data on airline delays are drawn from ADV and Association of European Airlines (AEA) for, respectively, domestic and international O&Ds. The AEA releases quarterly details of European airliners' punctuality performance at 27 key airports. The reports are based on a voluntary commitment by the association's members, e.g. 31 major airliners, to provide punctuality information according to a set of commonly defined standards. The data is available by departure, by arrival, and by length of delay, as well as by frequency, by relation, and by long-haul, short-haul, and domestic flights. The airlines' delay-information for domestic airports was obtained from the ADV's quarterly statistics on punctuality. The information comprises airline delay data on 19 main airports in Germany; the data is separated into delays for domestic and international flights.

Punctuality is measured by comparing actual times of departure and arrival times to scheduled times. Reference points are when the aircraft leaves from or arrives at its parking stand. In accordance with the AEA's definition, based on the purposes of the report, flights more than 15 minutes off schedule are regarded as delayed. The airline delay corresponding to the particular route is constructed by taking the weighted average by the shares of delayed flights in the respective O&D airports.

The duration of flights between the relevant O&Ds is extracted manually, based on Lufthansa's printed flight plans for summer and winter.

Monthly prices of crude oil and jet kerosene and quarterly prices for plant coal were taken from, respectively, the Association of German Petroleum Industry, the International Energy Agency, and the Federal Office of Economics and Export Control.

[92] There are no overlapping LCAs entries; thus each entry represent a single route.

DB Netz AG offers its rail passenger service customers a variety of train path products such as express passenger service train paths, regular interval passenger service train paths, economy passenger service train paths, and passenger service light engine train paths. These are incorporated into the price of a train path by means of a range of factors. The length of a railroad and corresponding prices are identified for the fastest and most direct link between urban centers as well as for the inexpensive alternative to the regular interval services on both long-distance and local passenger transport services and cross-border express services. Using the European Infrastructure Charging Information System from RailNetEurope, the prices for cross-border train paths were calculated for the international routes.

In line with the conventional approach, we define the populations' catchments area as a region of approximately 100 km around the point of O&D and use the geographical breakdowns of population by administrative regions provided by statistical offices of the countries observed. The following table provides variable definitions as well as data sources for all our dependent as well as control variables.

Table 7: Definition of variables

Variable	Definition	Source
DEPENDENT VARIABLES		
lpax1	(Log) number of first class train passengers	DB: Internal database
lpax2	(Log) number of second class train passengers	DB: Internal database
lavprice1	(Log) average first class ticket price for first class	DB: Internal database
lavprice2	(Log) average second class ticket price	DB: Internal database
lrev1	(Log) first class revenue	DB: Internal database
lrev2	(Log) second class revenue	DB: Internal database
lpkm1	(Log) first class passenger – kms of train traffic	DB: Internal database DB: Train path prices softwares
lpkm2	(Log) second class passenger – kms of train traffic	DB: Internal database DB: Train path prices softwares

Variable	Definition	Source
LCA COMPETITION		
LCA	LCA=1 if LCA entered and operated during sample period, else LCA=0	On inquiry from various LCAs Press releases of LCAs Press releases of airports
presence06	presence06=1 if LCA was in operation before and during sample period, else presence06=0	Press releases of LCAs Press releases of airports ADV: Low cost monitors
domestic	domestic=1 if both origin and destination located within Germany, else domestic=0	
RAIL DEMAND SHIFTERS		
lorig_pop	(Log) population in the origin catchment's area	Statistical offices
ldest_pop	(Log) population in the destination catchment's area	Statistical offices
ldistance	(Log) road distance	Marco Polo's Route Planner 06/07
lkerosene	(Log) price for jet kerosene	International Energy Agency: Monthly Oil Market Reports
loil	(Log) price for crude oil	Association of German Petroleum Industry
AIRLINE SUPPLY & QUALITY		
lflights	(Log) number of flights	ADV: Route-based traffic and capacity database
lseats	(Log) number of seat, e.g. capacity	ADV: Route-based traffic and capacity database
lair_dur	(Log) flight duration (min)	Lufthansa's flight schedules
lagldelay	(Log) lagged flight delay on route	ADV: Punctuality statistics AEA: Airline delay reports
AUTOMOBILE QUALITY		
lauto_dur	(Log) duration by auto (min)	Marco Polo's Route Planner 06/07

Variable	Definition	Source
RAILWAY COSTS AND QUALITY		
lrailfast_price	(Log) cost for the fastest train path (€)	DB and RailNetEurope: Train path prices software
lraillow_price	(Log) lowest cost of train path (€)	DB and RailNetEurope: Train path prices software
lcoal	(Log) price for plant coal	Federal Office of Economics and Export Control
ltrain_dur	(Log) duration by train (min)	Marco Polo's Route Planner 06/07 DB time planner 06/07
ICE	ICE=1 for ICE train type, else ICE=0	
INSTRUMENTS		
lairlines_orig	(Log) number of operating airlines in the origin hub	Press releases of LCAs Press releases of airports ADV: Low Cost Monitors
lairlines_dest	(Log) number of operating airlines in the destination hub	Press releases of LCAs Press releases of airports ADV: Low cost monitors

Table 8: Entry of low cost airlines in the sample, January 2006-October 2007

Low cost airlines	Entry
Air Berlin	15
Cirrus Airlines	3
EasyJet	2
FlyNiki	2
Germanwings	1
Intersky	1
Ryanair	1
Sterling European Airways	2
TUIFly	6

Source: On inquiry from individual LCAs, press releases of LCAs, press releases of airports.

A2.4 Overview of regressions tables

Summary of robustness checks: long-term effects of LCA entry
Table 10-table 17 provide panel data estimates for each of our 8 dependent variables in turn. In each table, each column corresponds to a different regression. In each case, heteroskedasticity-robust standard errors are reported in parentheses and 1, 2 and 3 stars pertain to significance at the 10%, 5%, and 1% levels, respectively.

The estimation method is mentioned in the column heading. Pooled OLS involves applying ordinary least squares (OLS) to equation (1) from the main text. RE apply feasible generalized least squares (FGLS) to equation (3); this effectively corrects for downward bias in our standard error estimates introduced by the presence of serial correlation in the error term. If our right-hand-side variables are not correlated with the unobserved effect c_i, both fixed effects (FE) and RE are consistent, but RE are more efficient. If our explanatory variables are correlated with the unobserved effect, FE is consistent, but RE is not. Although our Hausman tests typically favor a RE over a FE specification, we nevertheless present our FE estimates by way of comparison.

2SLS refers to standard 2-stage least squares: in the first stage regression, LCA_{it} is regressed linearly on all exogenous explanatory variables ($\mathbf{z}_{it}$ as well as instruments). And in the second stage, the predicted value of the dependent variable in stage 1 is used as an instrument for LCA_{it}, along with all other exogenous regressors.

Whereas this 2SLS is consistent, it is typically not efficient in the presence of binary endogenous variables (such as LCA_{it}.) In the next column we therefore follow a procedure 18.1 in Wooldridge (2002), p. 628, which improves efficiency. This involves a stage 0 regression in which we run a probit with LCA_{it} as our dependent variable and *all* exogenous regressors (including our two instruments lairlines_orig and lairlines_dest) on the right hand side. The predicted value from this regression is then used as the sole regressor in the first stage of the standard 2SLS procedure.

The latter method, while more efficient, can be extremely imprecise. Precision is improved using the ML control function approached described above. These results are presented in the last 2 columns of the price regression tables.[93]

"Complete sample" refers to all observations in the sample (except with those with missing values for the dependent variable). "Additional controls" refers to

[93] Corresponding IV estimation results for the model with additional controls are not presented here in the interest of saving space, but are available upon request.

the full set of controls. In the "restricted sample" columns were run the "complete sample" *specification* on the set of *observations* used in the estimation of the neighboring RE estimation for the "model with additional controls". We do this to see whether results in the model with additional controls are driven by the sample or the controls.

A2.5
Summary of results: Control variables

The following table provides a summary of the sign and significance of coefficients for the model with additional controls RE estimates.

Table 9: Summary of RE results for control variables

VARIABLES	Lpax2	lavprice2	lrev2	lpkm2	lpax1	lavprice1	lrev1	lpkm1
presence06	-	-	-	-	-	+	-	-
domestic	+***	-***	+***	+***	+***	-***	+***	+*
lorig_pop	+	+*	+*	+	+	+***	+	-
ldest_pop	-***	+***	-***	-***	-***	+***	-***	-***
ldistance	-*	+***	-		-*	+***	+	
ICE	+***	-***	+***	+***	+***	-	+***	+**
lseats	-	+***	+	-	-	+	+	+
lflights	+**	-***	+*	+**	+***	-*	+**	+***
lagldelay	-**	+	-**	-*	-***	+*	-***	-***
lauto_dur	+	-	+	+	-	-	-	+
ltrain_dur	-***	+***	-***	-***	-***	+***	-***	-***
lair_dur	-	+***	-	-	+	+	+	+
lrailfast_price	-	+	-	+	+	+*	+	+
lraillow_price	-	+	+	+	-**	+	-**	-

Note: This table provides a summary of the sign and significance of coefficients for the model with additional controls RE estimates from the corresponding appendix regression. *** p<0.01, ** p<0.05, * p<0.

Perhaps the first thing one notices in this table is how many variables have a significant bearing on some or all of the outcomes of interest in this study. This suggests our controls have bite—something confirmed by the large R-squareds associated with our model with additional controls. A comparison of the first four columns with the last four columns reveals, moreover, that the results are remarkably consistent for first and second class.

Significant coefficients associated with passenger numbers are mirrored in the revenue and pkm coefficients, so we restrict our description of the above table to prices and passenger numbers. Here we only discuss the sign and significance of the controls, since these are not the focus of this report. The reader is referred to the regression table corresponding to the column headings in order to verify the magnitudes of these coefficients. As row 1 indicates, LCA presence in 2006 (presence06) is associated with a negative coefficient, although this is always insignificant. Moreover, as should be expected, rail outcomes are much more responsive to own-travel duration than travel duration in other modes of transport.

Domestic O&Ds are characterized by significant lower prices and higher passenger numbers than international routes. Larger destination populations (ldest_pop) are associated with higher prices and (marginally) lower passenger numbers. More distant O&Ds (ldistance) are characterized by higher prices, probably reflecting the higher costs associated with these routes, with commensurately lower passenger numbers. This is likely to reflect substitution away from train travel toward air travel for sufficiently long-distance hauls. O&Ds serviced by the ICE alone have a lower second class price than those also serviced by other types of trains. The first class price is no different depending on train quality. ICE-serviced O&Ds also have significantly larger passenger numbers. This is likely to reflect both a positive quality effect in terms of ICE services offered, reductions in travel distances, and the possibility that ICEs are more likely to provide a direct connection, which travelers prefer quite apart from lower travel duration.

Turning to airline controls, airline seats (lseats) offered are associated with a positive coefficient effect on second class prices. This may well be capturing a general demand effect, given that the point estimate on the passenger numbers is insignificant. The number of flights (lflights) has a significant negative (positive) coefficient associated with prices (passenger numbers). This may either be capturing capacity expansion by both rail and airlines or be corroborative evidence for the possibility that DB faces competition not only from LCAs but from the airline industry in general.

Plane delays, which we include with one-month lags to permit for adjustment, are associated with a significant reduction in passenger numbers. This is somewhat puzzling, but may reflect the possibility that O&Ds with large delays are characterized by congestion or poor service, which leads consumers to opt for car rather than air or rail transport. Automobile travel time has no significant impact on passenger numbers or prices. The positive price effect in both train classes associated with train travel duration (ltrain_dur) and air travel duration (lair_dur) is likely to reflect larger costs associated with longer-distance travel. Train duration is significantly negatively associated with passenger numbers in both first and second class, whereas plane duration is not. This may well capture the commonly found observation that travelers prefer air travel to train travel for longer trips. Finally, rail track cost have, as expected, a positive coefficient associated with prices, marginally significant in the case of first class, and the price of the lowest-cost tracks are associated with a significant negative coefficient for first class passenger numbers.

A2.6
Summary of robustness checks: Long-term effects of LCA entry

Table 10: Estimation results and robustness check: Second class log (passenger numbers)

Dependent variable:	lpax2						
	1	2	3	4	5	6	7
VARIABLES	*pooled OLS*	*pooled OLS*	*RE*	*RE*	*RE*	*FE*	*FE*
LCA	-0.183*	-0.0195	-0.0707**	-0.186***	-0.150***	-0.133***	-0.112***
	(0.107)	(0.0768)	(0.0344)	(0.0343)	(0.0297)	(0.0296)	(0.0332)
presence06	0.0967	0.0717	-0.00907	-0.0836	-0.430		
	(0.106)	(0.0768)	(0.463)	(0.278)	(0.521)		
domestic	1.501***	-0.386***	1.517***	0.851***	1.110***		
	(0.0513)	(0.0794)	(0.240)	(0.220)	(0.393)		
lorig_pop	0.657***	-0.321***	0.710***	0.245	0.775***	9.539***	9.956***
	(0.0427)	(0.0491)	(0.181)	(0.160)	(0.273)	(-1.763)	(-1.790)
ldest_pop	-0.613***	-0.282***	-0.657***	-0.615***	-0.354	5.625***	6.135***
	(0.0432)	(0.0641)	(0.186)	(0.159)	(0.281)	(-1.554)	(-1.557)

Dependent variable:	lpax2						
	1	2	3	4	5	6	7
lauto_km	-1.843***	-0.535***	-1.790***	-0.939*	-2.608***		
	(0.0777)	(0.190)	(0.280)	(0.535)	(0.459)		
ICE	1.570***	0.0616	1.661***	0.943***	1.414***		
	(0.0551)	(0.0572)	(0.241)	(0.193)	(0.357)		
lsits		0.0455		-0.0132			-0.0317
		(0.0459)		(0.0389)			(0.0379)
lflights		1.733***		0.282**			-0.110
		(0.119)		(0.113)			(0.110)
lagldelay		-7.001***		-0.351**			-0.238
		(0.370)		(0.175)			(0.150)
lauto_dur		-0.112		0.311			
		(0.147)		(0.424)			
ltrain_dur		-1.333***		-2.203***			
		(0.122)		(0.362)			
lair_dur		0.121*		-0.0315			-0.0161
		(0.0632)		(0.0313)			(0.0311)
lrailfast_price		-0.371***		-0.00910			0.00031
		(0.0722)		(0.0207)			(0.0210)
lraillow_price		-0.618***		0.0641			0.120
		(0.167)		(0.125)			(0.127)
Constant	14.97***	46.10***	14.42***	26.63***	18.19***	-118.7***	-125.6***
	(0.920)	-1.147	-3.272	-3.067	-5.005	(20.86)	(21.24)
Time dummies	YES	YES	YES	YES	YES	YES	YES
Fuel costs	YES	YES	YES	YES	YES	YES	YES
No. Obs	4421	1652	4421	1652	1652	1652	1652

Dependent variable:	lpax2						
	1	2	3	4	5	6	7
No. O&Ds	207	207	207	84	84	84	84
R-squared	0.491	0.865	0.490	0.684	0.596	0.0491	0.0444

Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

A Hausman test prefers a RE over a FE specification (p=0.889). Pooled OLS, RE, and FE results suggest there is a negative long term effect of LCA entry on second class passenger numbers. This is larger in the model with additional controls (column 4) than the complete sample (column 3), but column 5, which applies only the complete sample controls to the sample of the model with additional controls suggests this is a consequence of this restricted sample rather than the controls per se. The FE estimates are consistent with the RE estimates, suggesting a negative effect which is somewhere between the complete sample and model with additional controls.

Table 11: Estimation results and robustness check: Second log (average price)

Dependent variable:	lavprice2									LCA
	1	2	3	4	6	7	8	9	10	11
VARIABLES	pooled OLS	pooled OLS	RE	RE	FE	FE	2SLS	W-2SLS	ML	
LCA	-0.00153	0.0185	0.0241	0.000926	-0.00639	-0.0115	-1.292***	-0.825***	-0.314**	
	(0.0237)	(0.0137)	(0.0262)	(0.0107)	(0.00864)	(0.0107)	(0.241)	(0.202)	(0.129)	
presence06	-0.0116	-0.0626***	0.0264	-0.0405			0.0245	0.0115	-0.000711	
	(0.0184)	(0.013)	(0.0677)	(0.0387)			(0.029)	(0.0236)	(0.0213)	
domestic	-0.222***	0.0562***	-0.208***	-0.155***			-0.178***	-0.194***	-0.229***	
	(0.0102)	(0.015)	(0.0362)	(0.038)			(0.018)	(0.0145)	(0.0106)	
lorig_pop	-0.0128*	0.0386***	-0.0278	0.0420*	-1.753**	-1.911**	0.00495	-0.00146	-0.00897	
	(0.00667)	(0.00828)	(0.0212)	(0.0231)	(0.777)	(0.786)	(0.0111)	(0.0089)	(0.00669)	
ldest_pop	0.136***	0.0936***	0.129***	0.194***	-2.809***	-3.074***	0.0816***	0.101***	0.135***	
	(0.00871)	(0.011)	(0.0357)	(0.0254)	(0.607)	(0.608)	(0.0177)	(0.0143)	(0.00889)	

Dependent variable:	lavprice2									LCA
	1	2	3	4	6	7	8	9	10	11
lauto_km	0.575***	0.318***	0.523***	0.505***			0.621***	0.605***	0.577***	
	(0.0164)	(0.051)	(0.0437)	(0.0963)			(0.0211)	(0.019)	(0.0168)	
ICE	-0.0865***	-0.0321***	-0.0688*	-0.0938***			-0.125***	-0.111***	-0.0829***	
	(0.0103)	(0.0101)	(0.0388)	(0.0331)			(0.0141)	(0.0126)	(0.0103)	
lsits		0.0312***		0.0317**		0.0280*				
		(0.0095)		(0.0157)		(0.0158)				
lflights		-0.105***		-0.111***		-0.0612				
		(0.0241)		(0.0411)		(0.0454)				
lagldelay		1.219***		0.0563		-0.0318				
		(0.0686)		(0.0416)		(0.0412)				
lauto_dur		0.0778		-0.07						
		(0.0473)		(0.0833)						
ltrain_dur		0.0862***		0.211***						
		(0.0192)		(0.0522)						

Dependent variable:	lavprice2									LCA
	1	2	3	4	6	7	8	9	10	11
lair_dur		0.0283***		0.0278**		0.0251**				
		(0.0107)		(0.0111)		(0.0106)				
lrailfast_price		0.109***		0.000516		-0.0113				
		(0.0195)		(0.011)		(0.0111)				
lraillow_price		0.0566*		0.00767		-0.0415				
		(0.0333)		(0.0465)		(0.0501)				
lairlines_orig										0.720***
										(0.0645)
lairlines_dest										0.128**

Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

A Wooldridge (2002) test for serial autocorrelation leads us to reject the null hypothesis of no serial autocorrelation at the 63% level.[94] This suggests that RE should be chosen over the pooled OLS model. A Hausman test similarly prefers a RE over a FE specification (p=0.983).

Pooled OLS, RE, and FE results suggest there is no significant effect of LCA entry on second class prices although FE, which allows for correlation between entry and the error term, does have a negative point estimate.

Standard tests lend support to our choice of instruments. A Sargan-Hansen test is unable to reject the null hypothesis that the error term in equation (1) is uncorrelated with the excluded instruments (Hansen J p-value = 0.282) and a Kleinbergen-Paap test under the null hypothesis that the equation is underidentified is strongly rejected (p=0).

The 2SLS point estimate is negative, as are all our IV estimates, suggesting that failure to control for selection in LCA entry may in fact, as we feared, result in upward bias of our estimate for δ . However, the point estimate is unreasonably large in absolute value. The Wooldridge-2SLS estimate presented in column 9 results in a less negative point estimate, but this too seems exaggerated. The ML estimate presented in column 10 does provide a more reasonable-looking point estimate, in accordance with the literature. Moreover, the point estimates for the instruments in the last column look reasonable. They suggest that LCAs are more likely to enter O&Ds on which LCAs have operations in the origin or the destination, with the former having a larger positive impact than the latter. Since this ML likelihood estimate is the most conservative (in terms of effect) and is regarded in the literature as being the most precise of these 3 IV methods, it is the one we choose to present in the main text of the report. It is worth emphasizing, however, that each IV method we employed in the complete sample resulted in even stronger negative long term effects on prices resulting from LCA entry than the one reported in column 10.

Table 12: Estimation results and robustness check: Second class log (revenue)

Dependent variables:	lrev2						
	1	2	3	4	5	6	7
VARIABLES	*pooled OLS*	*pooled OLS*	*RE*	*RE*	*RE*	*FE*	*FE*
LCA	-0.164	0.00273	-0.0458	-0.183***	-0.149***	-0.139***	-0.123***
	(0.108)	(0.0682)	(0.0336)	(0.0300)	(0.0259)	(0.0261)	(0.0297)

94 We use the xtserial command as written by Drukker (2003).

Dependent variables:	lrev2						
	1	2	3	4	5	6	7
presence06	0.0970	0.00666	0.0536	-0.120	-0.427		
	(0.101)	(0.0683)	(0.462)	(0.259)	(0.465)		
domestic	1.275***	-0.336***	1.323***	0.672***	0.908**		
	(0.0505)	(0.0707)	(0.221)	(0.209)	(0.356)		
lorig_pop	0.669***	-0.283***	0.674***	0.291*	0.760***	7.803***	8.065***
	(0.0412)	(0.0439)	(0.162)	(0.156)	(0.255)	(1.664)	(1.689)
ldest_pop	-0.494***	-0.188***	-0.605***	-0.435***	-0.256	2.739*	2.995**
	(0.0439)	(0.0576)	(0.217)	(0.155)	(0.261)	(1.415)	(1.427)
lauto_km	-1.286***	-0.212	-1.312***	-0.383	-1.961***		
	(0.0744)	(0.158)	(0.269)	(0.477)	(0.410)		
ICE	1.519***	0.0298	1.652***	0.848***	1.271***		
	(0.0539)	(0.0514)	(0.241)	(0.185)	(0.328)		
lsits		0.0798*		0.0115			-0.00504
		(0.0410)		(0.0335)			(0.0340)
lflights		1.628***		0.172*			-0.171*
		(0.106)		(0.100)			(0.100)
lagldelay		-5.784***		-0.373**			-0.284**
		(0.319)		(0.160)			(0.138)
lauto_dur		-0.0296		0.226			
		(0.107)		(0.339)			
ltrain_dur		-1.247***		-2.004***			
		(0.114)		(0.352)			
lair_dur		0.146**		-0.00519			0.00913
		(0.0582)		(0.0299)			(0.0299)
lrailfast_price		-0.259***		-0.0151			-0.0110
		(0.0575)		(0.0153)			(0.0157)

Dependent variables:	lrev2						
	1	2	3	4	5	6	7
lraillow_price		-0.566***		0.0428			0.0812
		(0.147)		(0.104)			(0.105)
Constant	14.60***	41.50***	15.40***	24.87***	17.77***	-76.55***	-79.88***
	(0.903)	(1.011)	(3.472)	(2.927)	(4.572)	(19.98)	(20.43)
Time dummies	YES	YES	YES	YES	YES	YES	YES
Fuel costs	YES	YES	YES	YES	YES	YES	YES
No. Obs	4415	1652	4415	1652	1652	1652	1652
No. O&Ds	207	207	207	84	84	84	84
R-squared	0.431	0.85	0.43	0.641	0.547	0.176	0.186

Note: robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Whereas pooled OLS and the complete sample RE estimates in column 3 indicate no significant long term effect associated with LCA entry, the RE estimates indicate a large negative effect, which is even magnified once we controls for other covariates (the column 5 estimate -0.149>-0.183, the column 4 estimate.) Although a Hausman test favors a RE to a FE specification (p=1), it is worth noting that FE estimates are significantly negative, large in absolute value, and robust to the inclusion of controls. Since revenues are equal to (average price) X (passenger numbers), and the latter is negative, these robust negative FE results reconfirm our suspicion that the RE price estimates may be overestimated.

Table 13: Estimation results and robustness check: Second class log (passenger kilometers)

Dependent Variable:	lpkm2						
	1	2	3	4	5	6	7
VARIABLES	*pooled OLS*	*pooled OLS*	*RE*	*RE*	*RE*	*FE*	*FE*
LCA	0.274***	0.0517	-0.0934***	-0.179***	-0.144***	-0.129***	-0.108***
	(0.100)	(0.0807)	(0.0353)	(0.0345)	(0.0301)	(0.0299)	(0.0336)

Dependent variable:	lpkm2						
	1	2	3	4	5	6	7
presence06	-0.0758	0.0944	-0.0437	-0.0735	-1.045*		
	(0.0971)	(0.0774)	(0.413)	(0.301)	(0.612)		
domestic	1.296***	-0.376***	1.452***	0.558**	0.904**		
	(0.0591)	(0.0834)	(0.303)	(0.239)	(0.405)		
lorig_pop	0.774***	-0.388***	0.830***	0.214	0.985***	10.39***	11.10***
	(0.0398)	(0.0519)	(0.223)	(0.175)	(0.272)	(-1.790)	(-1.823)
ldest_pop	-0.161***	-0.379***	-0.101	-0.735***	-0.495*	4.688***	5.492***
	(0.0424)	(0.0630)	(0.192)	(0.169)	(0.294)	(-1.597)	(-1.588)
ICE	1.510***	-0.0310	1.475***	0.909***	1.441***		
	(0.0580)	(0.0594)	(0.267)	(0.200)	(0.387)		
lsits		0.0320		-0.0184			-0.0353
		(0.0463)		(0.0389)			(0.0380)
lflights		1.881***		0.274**			-0.103
		(0.125)		(0.114)			(0.112)
lagldelay		-6.361***		-0.320*			-0.223
		(0.360)		(0.183)			(0.160)
lauto_dur		-0.121		0.307			
		(0.106)		(0.348)			
ltrain_dur		-1.510***		-2.202***			
		(0.121)		(0.317)			
lair_dur		0.105*		-0.0290			-0.0131
		(0.0616)		(0.0332)			(0.0331)
lrailfast_price		-0.314***		0.00246			0.00940
		(0.0508)		(0.0211)			(0.0214)

Dependent variable:	lpkm2						
	1	2	3	4	5	6	7
lraillow_price		0.498**		0.216			0.242*
		(0.200)		(0.132)			(0.135)
Constant	5.603***	48.06***	4.554*	28.41***	7.796**	-111.9***	-123.8***
	(0.495)	-1.107	-2.458	-3.334	-3.315	(21.07)	(21.46)
Time dummies	YES	YES	YES	YES	YES	YES	YES
Fuel costs	YES	YES	YES	YES	YES	YES	YES
No. Obs	3527	1652	3527	1652	1652	1652	1652
No. O&Ds	168	84	168	84	84	84	84
R-squared	0.375	0.807	0.371	0.578	0.394	0.158	0.170

Note: robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

A Hausman test favors a RE over a FE specification (p=0.991). The large negative RE point estimate is robust to the inclusion of controls (in fact, it becomes even more negative). It is also worth noting that it is consistent with the FE estimates, which lie somewhere between the RE complete sample and model with additional controls estimates.

Table 14: Estimation results and robustness check: First class log (passenger numbers)

Dependent Variable:	lpax1						
	1	2	3	4	5	6	7
VARIABLES	pooled OLS	pooled OLS	RE	RE	RE	FE	FE
LCA	-0.0545	0.0553	0.0030	-0.198***	-0.114***	-0.0873**	-0.0455
	(0.0964)	(0.0872)	(0.0435)	(0.0461)	(0.0394)	(0.0404)	(0.0477)
presence06	-0.0115	0.0532	-0.182	-0.143	-0.595		
	(0.103)	(0.0840)	(0.423)	(0.274)	(0.540)		

Dependent variable:	lpax1						
	1	2	3	4	5	6	7
domestic	1.772***	-0.513***	1.623***	0.842***	1.311***		
	(0.0523)	(0.0887)	(0.254)	(0.228)	(0.447)		
lorig_pop	0.590***	-0.349***	0.644***	0.143	0.922***	13.47***	14.05***
	(0.0423)	(0.0526)	(0.166)	(0.154)	(0.290)	(-3.491)	(-3.514)
ldest_pop	-0.382***	-0.423***	-0.577***	-0.884***	-0.479	9.500***	10.27***
	(0.0412)	(0.0742)	(0.168)	(0.182)	(0.348)	(-2.399)	(-2.493)
lauto_km	-1.998***	0.115	-2.016***	-0.316	-3.197***		
	(0.0767)	(0.213)	(0.278)	(0.571)	(0.414)		
ICE	1.426***	-0.119**	1.506***	0.650***	1.444***		
	(0.0562)	(0.0594)	(0.234)	(0.199)	(0.405)		
lsits		-0.0417		0.0284			-0.0113
		(0.0524)		(0.0821)			(0.0901)
lflights		1.960***		0.530***			-0.368
		(0.132)		(0.204)			(0.227)
lagldelay		-7.927***		-0.584***			-0.278*
		(0.434)		(0.167)			(0.152)
lauto_dur		-0.466***		-0.0484			
		(0.163)		(0.436)			
ltrain_dur		-2.165***		-3.038***			
		(0.143)		(0.377)			
lair_dur		0.107		0.0315			0.0730
		(0.0685)		(0.0522)			(0.0507)
lrailfast_price		-0.304***		0.0141			0.0294
		(0.0741)		(0.0330)			(0.0315)

Dependent variable:	lpax1						
	1	2	3	4	5	6	7
lraillow_price		-1.014***		-0.324**			-0.199
		(0.184)		(0.153)			(0.154)
Constant	12.94***	52.65***	14.03***	31.22***	19.41***	-185.7***	-195.7***
	(0.855)	(-1.390)	(-3.073)	(-2.881)	(-5.172)	(40.47)	(41.43)
Time dummies	YES	YES	YES	YES	YES	YES	YES
Fuel costs	YES	YES	YES	YES	YES	YES	YES
No. Obs	3916	1634	3916	1634	1634	1634	1634
No. O&Ds	201	84	201	84	84	84	84
R-squared	0.503	0.881	0.498	0.758	0.622	0.0360	0.0320:

Note: robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

A Hausman test prefers a RE over a FE specification (p=0.0.997). Both pooled OLS and RE for the model with additional controls suggest no long term effect on passenger numbers associated with LCA entry. This effect is large and negative in the model with additional controls with a more limited sample (column 4), a result that is robust to the inclusion of a large number of controls. The FE point estimates are negative for both the complete sample and the model with additional controls, and are significant in the former case.

Table15: Estimation results and robustness check: First class log (average price)

Dependent Variable:	lavprice2									LCA
	1	2	3	4	6	7	8	9	10	11
VARIABLES	Pooled OLS	pooled OLS	RE	RE	FE	FE	2SLS	W-2SLS	ML	
LCA	0.0337*	0.00166	0.0245	0.0356**	0.0251*	0.0268	-1.356***	-0.989***	-0.170***	
	(0.0189)	(0.0178)	(0.0176)	(0.0163)	(0.0129)	(0.0168)	(0.313)	(0.279)	(0.0511)	
presence06	0.0223	0.000584	0.038	0.0472			0.0556*	0.0467*	0.0299	
	(0.0197)	(0.0168)	(0.0658)	(0.0488)			(0.0312)	(0.0267)	(0.0194)	
domestic	-0.320***	0.0351*	-0.301***	-0.208***			-0.288***	-0.297***	-0.324***	
	(0.0108)	(0.0204)	(0.0414)	(0.0443)			(0.0193)	(0.0163)	(0.0108)	
lorig_pop	0.00851	0.101***	0.00283	0.0977***	-1.482	-1.557	0.0149	0.0132	0.00975	
	(0.00799)	(0.0104)	(0.0288)	(0.0281)	(1.14)	(1.166)	(0.0125)	(0.0105)	(0.00797)	
ldest_pop	0.163***	0.111***	0.191***	0.239***	-2.819***	-2.812***	0.0819***	0.103***	0.163***	
	(0.00754)	(0.0145)	(0.0302)	(0.0305)	(0.871)	(0.904)	(0.0241)	(0.0207)	(0.00752)	
lauto_km	0.689***	0.294***	0.715***	0.531***			0.721***	0.713***	0.691***	
	(0.0165)	(0.0613)	(0.0447)	(0.122)			(0.0216)	(0.0195)	(0.0166)	

Dependent variable:	lavprice2									LCA
	1	2	3	4	6	7	8	9	10	11
ICE	-0.0960***	0.0124	-0.106***	-0.041			-0.123***	-0.116***	-0.0947***	
	(0.0103)	(0.0131)	(0.0387)	(0.0369)			(0.0155)	(0.0137)	(0.0102)	
lsits		0.0354***		0.00912		-0.00743				
		(0.0125)		(0.0275)		(0.0383)				
lflights		-0.165***		-0.126*		0.00145				
		(0.0303)		(0.0683)		(0.0948)				
lagldelay		1.391***		0.143*		-0.0403				
		(0.0941)		(0.0823)		(0.0861)				
lauto_dur		0.0495		-0.106						
		(0.0515)		(0.0757)						
ltrain_dur		0.170***		0.294***						
		(0.0277)		(0.0769)						
lair_dur		0.0581***		0.0206		0.00357				
		(0.0132)		(0.01799		(0.0187)				

Dependent variable:	lavprice2									LCA
	1	2	3	4	6	7	8	9	10	11
lrailfast_price		0.141***		0.0224*		0.00487				
		(0.0221)		(0.0114)		(0.0107)				
lraillow_price		0.0752*		0.00907		-0.0726				
		(0.0427)		(0.0611)		(0.0653)				
lairlines_orig										0.674***
										(0.079)
lairlines_dest										0.140***
										(0.0433)
Constant	-0.905***	-5.679***	-1.226**	-3.030***	40.13***	40.91***	-0.0275	-0.224	-0.766***	-2.602***
	(0.173)	(0.29)	(0.522)	(0.595)	(12.8)	(13.21)	(0.882)	(0.741)	(0.174)	(0.14)
Time dummies	YES	YES	YES	YES	YES	YES	YES	YES	YES	
Fuel costs	YES	YES	YES	YES	YES	YES	YES	YES	YES	
No.Obs	3886	1631	3886	1631	1631	1631	3886	3886	3886	
No. O&Ds	201	84	201	84	84	84	201	201	201	
R-squared	0.59	0.822	0.588	0.757	0.0426	0.05	-0.0428	0.248		

Note: robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

A Wooldridge (2002) test for serial autocorrelation leads us to *reject* the null hypothesis of no serial autocorrelation at the 49% level.[95] This suggests that RE should be chosen over the pooled OLS model. A Hausman test similarly prefers a RE over a FE specification (p=1).

RE and FE results suggest there is no significant effect of LCA entry on second class prices for the complete sample. The model with additional controls suggests a curious positive effect, although as a comparison of row 1 in columns 3 and 4 indicates, this RE result is sample-driven. The point estimate in column 6, by contrast, indicates an insignificant coefficient. A comparison of the model with additional controls RE and FE point estimates lends support to our concern that RE estimates may be subject to upward selection bias.

Standard tests lend support to our choice of instruments. A Sargan-Hansen test is unable to reject the null hypothesis that the error term in equation (1) is uncorrelated with the excluded instruments (Hansen J p-value = 0.251) and a Kleinbergen-Paap test under the null hypothesis that the equation is underidentified is strongly rejected (p=0).

The 2SLS point estimate is negative, as are all our IV estimates, suggesting that failure to control for selection in LCA entry may in fact, as we feared, result in upward bias of our estimate for δ . However, the point estimate is unreasonably large in absolute value. The Wooldridge-2SLS estimate presented in column 9 results in a less negative point estimate, but this too seems wildly exaggerated. The ML estimate presented in column 10 does, provide a considerably more reasonable-looking point estimate, in accordance with the literature. Moreover, the point estimates for the instruments in the last column look reasonable, mirroring those for lavprice2. Since this ML likelihood estimate is the most conservative (in terms of effect) and is regarded in the literature as the most precise of these 3 IV methods, it is the one we choose to present in the main text of the report. It is worth emphasizing, however, that each IV method we employed resulted in even stronger negative long term effects on prices resulting from LCA entry than the one in reported in column 10.

95 We use the xtserial command as written by Drukker (2003).

Table 16: Estimation results and robustness check: First class log (revenue)

Dependent variable:	lrev1						
	1	2	3	4	5	6	7
VARIABLES	*pooled OLS*	*pooled OLS*	*RE*	*RE*	*RE*	*FE*	*FE*
LCA	0.00412	0.0956	0.0376	-0.171***	-0.0737*	-0.0536	-0.0129
	(0.0946)	(0.0804)	(0.0460)	(0.0471)	(0.0384)	(0.0402)	(0.0520)
presence06	0.0405	0.0510	-0.140	-0.0829	-0.503		
	(0.0936)	(0.0786)	(0.391)	(0.266)	(0.480)		
domestic	1.497***	-0.541***	1.352***	0.542**	1.036**		
	(0.0517)	(0.0830)	(0.250)	(0.235)	(0.426)		
lorig_pop	0.656***	-0.256***	0.698***	0.188	0.954***	11.91***	12.34***
	(0.0412)	(0.0497)	(0.166)	(0.156)	(0.280)	(3.931)	(3.971)
ldest_pop	-0.254***	-0.323***	-0.495***	-0.716***	-0.351	5.979**	6.635**
	(0.0403)	(0.0708)	(0.170)	(0.183)	(0.324)	(2.594)	(2.723)
lauto_km	-1.387***	0.472**	-1.416***	0.312	-2.557***		
	(0.0721)	(0.192)	(0.293)	(0.557)	(0.377)		
ICE	1.393***	-0.117**	1.503***	0.558***	1.370***		
	(0.0550)	(0.0576)	(0.237)	(0.199)	(0.385)		
lsits		0.0283		0.0409			-0.00906
		(0.0541)		(0.126)			(0.146)
lflights		1.779***		0.606**			-0.378
		(0.132)		(0.292)			(0.319)
lagldelay		-6.729***		-0.657***			-0.337**
		(0.383)		(0.176)			(0.160)
lauto_dur		-0.440***		-0.196			
		(0.130)		(0.415)			

Dependent variable:	lrev1						
	1	2	3	4	5	6	7
ltrain_dur		-2.049***		-2.819***			
		(0.141)		(0.365)			
lair_dur		0.123*		0.0267			0.0745
		(0.0681)		(0.0541)			(0.0517)
lrailfast_price		-0.173***		0.0233			0.0309
		(0.0628)		(0.0342)			(0.0330)
lraillow_price		-0.978***		-0.427**			-0.308
		(0.174)		(0.188)			(0.197)
Constant	12.21***	47.96***	13.78***	30.11***	18.80***	-139.3***	-146.9***
	(0.816)	(1.256)	(3.291)	(2.938)	(4.840)	(44.02)	(45.15)
Time dummies	YES	YES	YES	YES	YES	YES	YES
Fuel costs	YES	YES	YES	YES	YES	YES	YES
No. Obs	3886	1631	3886	1631	1631	1631	1631
No. O&Ds	201	84	201	84	84	84	84
R-squared	0.448	0.857	0.439	0.744	0.573	0.0764	0.0699

Note: robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Both pooled OLS and RE for the model with additional controls suggest no long term effect on revenues associated with LCA entry. This effect is large and negative in the model with additional controls (column 3), a result driven by the inclusion of controls rather than sample effects per se. The FE point estimates are negative for both the complete sample and the model with additional controls, but are insignificant in both cases.

Table 17: Estimation results and robustness check: First class log (passenger kilometers)

Dependent Variable:	lpkm1						
	1	2	3	4	5	6	7
VARIABLES	pooled OLS	pooled OLS	RE	RE	RE	FE	FE
LCA	0.208*	0.148	0.0103	-0.263***	-0.132***	-0.0954**	-0.0401
	(0.121)	(0.0923)	(0.0600)	(0.0540)	(0.0475)	(0.0457)	(0.0550)
presence06	-0.485***	0.0881	-0.430	-0.106	-1.440***		
	(0.115)	(0.0915)	(0.419)	(0.281)	(0.467)		
domestic	1.690***	-0.524***	1.653***	0.452*	1.139**		
	(0.0696)	(0.102)	(0.314)	(0.246)	(0.479)		
lorig_pop	0.773***	-0.397***	0.979***	-0.0080	1.246***	17.01**	18.11**
	(0.0483)	(0.0579)	(0.234)	(0.155)	(0.290)	(-7.200)	(-7.312)
ldest_pop	-0.149***	-0.518***	-0.180	-1.125***	-0.669*	12.19***	13.39***
	(0.0488)	(0.0780)	(0.199)	(0.210)	(0.404)	(-3.714)	(-3.974)
ICE	1.500***	-0.149**	1.523***	0.552**	1.617***		
	(0.0687)	(0.0701)	(0.302)	(0.234)	(0.498)		
lsits		-0.0111		0.0427			-0.0053
		(0.0576)		(0.104)			(0.117)
lflights		2.093***		0.973***			-0.466
		(0.146)		(0.265)			(0.294)
lagldelay		-7.702***		-0.668***			-0.140
		(0.445)		(0.217)			(0.211)
lauto_dur		-0.228**		0.202			
		(0.0990)		(0.267)			
ltrain_dur		-2.152***		-2.839***			
		(0.128)		(0.272)			

Dependent variable:	lpkm1						
	1	2	3	4	5	6	7
lair_dur		0.133*		0.000166			0.0671
		(0.0729)		(0.0621)			(0.0553)
lrailfast_price		-0.157***		0.0405			0.0460
		(0.0509)		(0.0344)			(0.0352)
lraillow_price		0.154		-0.182			-0.134
		(0.194)		(0.178)			(0.185)
Constant	3.416***	56.65***	1.844	36.28***	4.771	-231.2***	-249.5***
	(0.589)	-1.424	-2.787	-3.274	-4.137	(79.86)	(82.83)
Time dummies	YES	YES	YES	YES	YES	YES	YES
Fuel costs	YES	YES	YES	YES	YES	YES	YES
No. Obs	3325	1634	3325	1634	1634	1634	1634
No. O&Ds	168	84	168	84	84	84	84
R-squared	0.344	0.818	0.341	0.715	0.400	0.066	0.070

Note: robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.

A Hausman test favors a RE over a FE specification (p=1). Although the complete sample RE estimates are negative, for the limited sample in the model with additional controls (column 4), entry has a large negative impact on revenues, which increases substantially upon the inclusion of additional controls (column 3). FE point estimates are negative and are significant for the complete sample estimates.

Appendix 3 Cases in the railway sector and intermodal cases

Table 18: Cases in the railway sector

Decision	Year	Transaction/Claim	Parties	Relevant market
EC M.4746	2007	Acquisition	Deutsche Bahn/English Welsh & Scottish Railway Holdings Limited (EWS)	National and international freight forwarding and logistics services
EC M.4806	2007	Joint Venture	DSB/FIRST/ÖRESUNDSTÅG	Public passenger services by rail in the areas/routes covered by the two franchises
EC M.4695	2007	Acquisition	Alstom/SBB Cargo/JV	Rail transport services
EC M.4398	2006	Acquisition	Veolia Cargo/Rail Link/JV	Goods transport
EC M.4294	2006	Acquisition	Arcelor Profil Luxembourg/SNCFL/CFL Cargo	Goods transport
BKA B9 – 50/05	2005	Acquisition	Railion(Deutsche Bahn)/RAG	Goods transport

Decision	Year	Transaction/Claim	Parties	Relevant market
EC M.3554	2004	Acquisition	SERCO/NEDRAILWAYS/NORTHERN RAIL	Public passenger rail services in the UK, including heavy and light rail services and metro services
EC M.3369	2004	Acquisition	EURAILCO/TRANSREGIO	Public passenger rail services
EC M.4070	2004	Acquisition	LONDON SOUTH EASTERN RAILWAY/THE INTEGRATED KENT RAIL FRANCHISE	Public passenger rail services
EC M.3150	2003	Joint Venture	SNCF/TRENITALIA	Rail shuttle service for lorries and semi-trailers through the Fréjus tunnel under Mont Cenis linking France and Italy
EC M.2960	2002	Acquisition	KEOLIS/AB STORSTOCKHOLMS LOKALTRAFIK/BUSSLINK	Public transport contracted by tender in Sweden
EC M.2905	2002	Acquisition	DEUTSCHE BAHN/STINNES	Freight service
EC M.2646	2001	Acquisition	RHENUS/VIA VERKEHR HOLDING (SNCF) / RHENUS - KEOLIS	Goods transport
EC M.2446	2001	Acquisition	Govia/Connex South Central	Passenger rail services
EC M.1305	1998	Joint Venture	EUKL, LCR, SNCF, NEG, SNCB	Passenger rail services
EC M.34.600	1998	Joint Venture	ENS, EPS, UIC, NS and SNCF	Passenger rail services
EC M.901	1997	Acquisition	GO-AHEAD/VIA/THAMESLINK	Passenger rail services
EC M.816	1996	Acquisition	CGEA/South Eastern Train Co Ltd	Passenger rail services
EC M.748	1996	Acquisition	CGEA Networks South Central	Passenger rail services

Table 19: Intermodal cases

Decision	Year	Claim	Parties	Relevant market
07-D-39	2007	Predatory Practices	British Airways Plc / SNCF and Eurostar Group Limited (EGL)	High-speed passenger transport between Paris and London

Appendix 4
Mergers and alliances in the airline sector

Table 20: Mergers in the airline sector

Decision	Year	Transaction/Claim	Parties	Relevant market
EC M.4439	2007	Acquisition	Ryanair/Aer Lingus	Scheduled air transport of passengers within EEA
EC M.3770	2005	Acquisition	Lufthansa/Swiss	Scheduled passenger air transport services, cargo transport services within EEA
EC M.3940 BKA B9-147/00	2004	Acquisition	Lufthansa/Eurowings	Scheduled air transport of passengers within Germany and cross-border short and mid haul flights
EC M.3280	2004	Acquisition	Air France/KLM	Scheduled air transport of passengers, air cargo transport co-operations worldwide
EC M.2041	2001	Acquisition	United Airlines/US Airways	Scheduled air transport of passengers between the EEA and the USA

Decision	Year	Transaction/Claim	Parties	Relevant market
UK CC Cm 4838	2000	Acquisition	Air Canada/Canadian Airlines	Scheduled passenger air transport services, cargo transport services
UK CC Cm 4346	1999	Acquisition	British Airways/City Flyer Express	Scheduled passenger air transport services, cargo transport services from/to Great Britain

Table 21: Alliances in the airline sector

Decision	Year	Transaction/Claim	Parties	Relevant market
COMP/37.984	2007	Alliance Agreement	Air France, Aeromexico, Delta Air Lines, Korean Air (Member airlines of SkyTeam)	Networkwide
COMP/37.749	2005	Alliance Agreement	Austrian Airlines (OS) - SAS (SK)	Networkwide especially between Austria and Nordic countries
COMP/38.284	2004	Alliance Agreement	Air France (AF) - Alitalia (AZ)	Networkwide especially between France and Italy
COMP/38.479	2004	Alliance Agreement	British Airways (BA) - Iberia (IB) - GB Airways (GT)	Networkwide especially between Spain and U.K.
COMP/38.477	2003	Alliance Agreement	British Airways (BA) - SN Brussels Airlines (QG)	Networkwide especially between Belgium and U.K.
COMP/36.201	2002	Alliance Agreement	KLM Royal Dutch Airlines (KL) - Northwest Airlines (NW)	Networkwide especially between Europe and U.S.
COMP/36.076	2002	Alliance Agreement	Lufthansa (LH) - SAS (SK) - United Airlines (UA)	Networkwide especially between Europe and U.S.
EC M.37.730	2002	Alliance Agreement	Lufthansa/Austrian Airlines	Scheduled air transport of passengers between Germany and Austria and co-operations worldwide

Decision	Year	Transaction/Claim	Parties	Relevant market
COMP/37.444	2001	Abuse of a dominant position	Finnair (AY) - Maersk Air (DM)	Between Copenhagen and Stockholm
COMP/37.812	2001	Alliance Agreement	bmi British Midland (BD) - Lufthansa (LH) - SAS (SK)	Within EEA to/from London Heathrow/Stansted
OFT CP/1535-01	2001	Alliance Agreement	British Midland/United Airlines	Scheduled passenger air transport services, cargo transport services from/to Great Britain
EC M.38.477	1998	Alliance Agreement	British Airways/SN Brussels Airlines	Scheduled passenger air transport services, cargo transport services within EEA

Appendix 5 Data sources on railway and airline statistics

Table 22: Railway data

Eurostat	
Database	Railway Transport Statistics
Period coverage	1995-2006
Periodicity	Annual and limited quarterly
Observation coverage	Europe region
Indicators	Quarterly passengers transported Railway passenger transport by type of transport (national/international) Train-movements, by type of vehicle and source of power Length of tracks Length of lines, by number of tracks Length of lines, by nature of transport Number of locomotives, by source of power Capacity of passenger railway vehicles, by type of vehicle Load capacity of wagons, by status of enterprise
Remarks	Data aggregated over railway companies at country level O&D data is not available

Eurostat	
Database	Railway Transport Statistics
Period coverage	1995-2006
Periodicity	Annual and limited quarterly
Observation coverage	Europe region
Indicators	Quarterly passengers transported Railway passenger transport by type of transport (national/international) Train-movements, by type of vehicle and source of power Length of tracks Length of lines, by number of tracks Length of lines, by nature of transport Number of locomotives, by source of power Capacity of passenger railway vehicles, by type of vehicle Load capacity of wagons, by status of enterprise
Remarks	Data aggregated over railway companies at country level O&D data is not available

Eurostat	
Database	Railway Transport Statistics
Period coverage	1995-2006
Periodicity	Annual and limited quarterly
Observation coverage	Europe region
Indicators	Quarterly passengers transported Railway passenger transport by type of transport (national/international) Train-movements, by type of vehicle and source of power Length of tracks Length of lines, by number of tracks Length of lines, by nature of transport Number of locomotives, by source of power Capacity of passenger railway vehicles, by type of vehicle Load capacity of wagons, by status of enterprise
Remarks	Data aggregated over railway companies at country level O&D data is not available

Railteam partners	
Database	Sales data for Railteam
Period coverage	2005 Forecast for 2010
Periodicity	Annual
Observation coverage	
Indicators	Origin and destination Number of transfers/Transfer services Operators bit field Travel time by modes Modal shares
Remarks	Railteam O&D

Table 23: Airline data

American Express Consulting Services	
Database	European Corporate Travel Index
Period coverage	Q4,1999 - Q4,2004
Periodicity	Quarterly
Observation coverage	439 city-pairs covering 51 Western European cities
Indicators	*Average fares:* Business and leisure travels Categories such as economic class, economic leisure class, business class, restricted business class, first class, restricted first class
Remarks	O&D data is available Aggregated over airlines Disaggregated over price category Data for 2005 and 2006 is not available

Association of European Airlines (AEA)	
Database	Traffic and Capacity Data
Period coverage	From 2001 up to present
Periodicity	Annual, quarterly and monthly
Observation coverage	30 member European airlines
Indicators	*Passengers traffic and capacity indicators:* Revenue Passenger km Available Seat km Passenger Load Factor Average Number of Seats per Flight Average Distance/ Flight *Cost indicators:* Operating Ratio Unit cost Average Fuel price per Gallon *Quality indicators:* Punctuality
Remarks	Data aggregated over airlines O&D data is not available

Arbeitsgemeinschaft Deutscher Verkehrsflughäfen (ADV)	
Database	Passenger Traffic Data
Period coverage	1997-2007
Periodicity	Monthly and annual
Observation coverage	Airlines operating in Germany and from/to Germany
Indicators	*Passengers traffic and capacity indicators:* Number of flights Revenue passengers carried Passenger km Passenger load factor Flight duration
Remarks	O&D data is available Passenger traffic in Germany and between Germany and main airports abroad are covered

International Civil Aviation Organization (ICAO)	
Database	ICAO Airline Data Traffic by Flight Stage
Period coverage	1997-2006
Periodicity	Annual
Observation coverage	1,500 city pairs worldwide
Indicators	*Passengers traffic and capacity indicators:* Passengers carried Passengers km Seats km available Passenger load factor
Remarks	O&D data is available Disaggregated over air carriers International city-pairs are covered

International Civil Aviation Organization (ICAO)	
Database	ICAO Airline Data On-Flight Origin and Destination
Period coverage	1997-2006
Periodicity	Annual (1997-2006) and quarterly (Q1, 2002 - Q3, 2006)
Observation coverage	1,500 city pairs worldwide
Indicators	*Passengers traffic indicator:* Passengers carried
Remarks	O&D data is available Disaggregated over air carriers International city-pairs are covered

International Air Transport Association (IATA)	
Database	Origin Destination Statistics (ODS)
Period coverage	From 1990 to present
Periodicity	Monthly
Observation coverage	240 member international airlines
Indicators	*Passenger traffic indicator:* Passenger numbers Class of travel such as first, intermediate/business and economy
Remarks	O&D data is available Aggregated over air carriers at country and region level

International Air Transport Association (IATA)	
Database	Route Area Statistics (RAS)
Period coverage	From 1990 to present
Periodicity	Monthly
Observation coverage	240 member international airlines
Indicators	*Passengers traffic and capacity indicators:* Passenger volumes Revenue passengers km Available seat km Passenger load factor
Remarks	O&D data is available Aggregated over air carriers at country and region level

Official Airline Guide (OAG)	
Database	OAG Max Analysis incl. ICAO Analysis Traffic Data
Period coverage	From 1992 to present
Periodicity	Passenger annual traffic data Aircraft capacity monthly and daily data
Observation coverage	1,500 city pairs worldwide
Indicators	*Passengers' traffic and capacity indicators:* Number of flights Passenger seats available Revenue passengers carried Passenger km Passenger load factor
Remarks	O&D data is available Disaggregated over air carriers Germany's domestic flight routes are covered

Eurostat	
Database	Air Transport Statistics
Period coverage	1995 - 2006
Periodicity	Annual
Observation coverage	National intra-EU air passenger transport by reporting country and EU partner country National intra-EU air passenger transport by main airports in each reporting country and EU partner country
Indicators	*Passengers traffic indicator:* Total passengers carried Total direct transit passengers Total aircraft movements
Remarks	O&D data is available Aggregated over air carriers at country level

Statistisches Bundesamt	
Database	Fachserie 8/Reihe 6, Verkehr/Luftverkehr
Period coverage	Dec, 2002 – Sep, 2007
Periodicity	Monthly
Observation coverage	Air passenger transport by main airports in Germany and from/to Germany
Indicators	Passengers embarked/disembarked
Remarks	O&D data is available Aggregated over air carriers at O&D level Germany's domestic flight routes are covered

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About ESMT

ESMT European School of Management and Technology was founded in October 2002 on the initiative of 25 leading German companies and institutions. The founders aimed to establish an international business school, based in Germany, with a distinct European focus. As a private institution of higher education, ESMT provides executive education (since 2003) and an international MBA program (since 2006). ESMT headquarters is located in Berlin with a further campus is in Cologne. ESMT is fully accredited by German authorities as a private institution of higher education.

High impact learning

ESMT research and teaching focuses on practice relevance and applicability. High impact learning allows participants to translate what they have learned into action as soon as they get back to their companies and to bring about changes on the job. ESMT imparts participants with state-of-the-art analytical methods in management and teaches them to solve real-life management issues. The aim is to enable participants to take responsibility and accomplish change. ESMT faculty, made up both practiceoriented academics and theory-oriented experts, supports this style of teaching.

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About ESMT Competition Analysis

ESMT Competition Analysis is working on central topics in the field of competition policy and regulation. These include case-related work on European competition matters, e.g. merger, antitrust or state aid cases, economic analysis within regulatory procedures and studies for international organizations on competition policy issues. ESMT Competition Analysis applies rigorous economic thinking with a unique combination of creativity and robustness, in order to meet the highest quality standards of international clients.

Fully integrated into an international business school, ESMT Competition Analysis benefits from in-depth business experience of ESMT professionals as well as exceptional research capabilities of ESMT professors specialized in industrial organization, quantitative methods or with relevant sector knowledge. As a result, the practice group Competition Analysis mirrors ESMT's overall approach by combining activities in teaching, research and consulting, with an emphasis on the latter.

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