Competition for Railway Markets: The Case of Baden-Württemberg

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Abstract: This paper studies the effects of introducing competition for local passenger railway markets in the German state of Baden-Württemberg. We compare the evolution of the frequency of service on lines that were exposed to competition for the market with lines procured by direct negotiations with the incumbent. Our results suggest that the competitively procured lines enjoyed a stronger growth of the frequency of service than those that were not procured competitively, even after controlling for various line characteristics that might have had an independent influence on the frequency of service. Our results further suggest that the effects of competition may depend strongly on the operator.

Keywords: Competition for the market, liberalization, passenger railways, procurement auctions

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1 Introduction

As a consequence of the railway reforms in the nineteen nineties, the former state monopolies are facing increasing competition in many European countries. The proponents of the reforms argue that this development will not only lead to decreasing transfer payments to railway operators, but also to a better service quality.[1] However, this opinion is not undisputed. First, there are serious arguments that cast doubt on the hope that the potential efficiency gains from liberalisation in the railway industry are similar to those in other sectors, most notably telecommunications.[2] Second, it is not obvious that the institutional details in the liberalized railway industry have been chosen in such a fashion that potential efficiency gains are realized.[3] From a-priori considerations, it is impossible to come to a definite conclusion regarding the pros and cons of liberalization as such, let alone the particular institutions chosen in the different European countries.

The empirical evaluation of the railway reforms is still in its infancy. A small number of contributions deals with the efficiency effects of various reforms in an international context on a highly aggregate level (Cantos et al. 1999, Friebel et al. 2003). Several contributions analyze the outcomes of the U.K. reform (Cowie 2002, Pollitt and Smith 2001). Our contribution concentrates on a concrete measure, namely the German *Regionalisierungsgesetz*, a law that was passed in 1993.[4] This measure led to a massive change in the procurement of regional passenger transportation. Even though transfer payments from the central government are still used to finance short-distance trains and other forms of public transport, the role of the central state for procurement is indirect. Each year, it distributes a substantial amount of money (around five billion Euro in each year between 1997 and 2004) to the 16 states (*Länder*) who are now responsible for the procurement of regional

[1] Unsurprisingly, a particularly optimistic perspective on the potential efficiency gains from competition comes from a report commissioned by *MehrBahnen*, an organisation of competitors of the German state enterprise *Deutsche Bahn* (pspc 2004). The report estimates the potential reduction in subsidies from relying on competitive mechanisms for procuring regional passenger services at 18-38%, depending on the type of service.

[2] For instance, there is no reason to expect similar technological improvements as in the telecoms sector, as the railroad technology is comparatively mature.

[3] For instance, there is no consensus as to the right extent of vertical separation. Also, it is not obvious how access prices should best be regulated, for instance in view of the implied investment incentives for network owners and operators. In the case of the British reform, both issues were hotly debated (see, e.g. Bühler et al. 2004).

[4] Officially, the law is known as *Gesetz zur Regionalisierung des öffentlichen Personennahverkehrs.* It was passed on December 27, 1993 as Article 4 of the *Eisenbahnneuordnungsgesetz,* which contains most of the legal foundations for the German railway reform.

passenger transport, and railway services in particular.[5] The states, in turn, delegated this task to newly founded agencies. These agencies are now allowed to use competitive franchising to procure the services, which typically means that firms bid in transfers demanded to carry out the required service obligations, with the lowest bidder having to supply the service in return for the demanded transfer. Importantly, however, agencies are not obliged to use such competitive procedures. On 20-25% of the passenger railway lines a substantial part of local passenger services is now procured in a (more or less) competitive fashion. On the remaining lines all services are still provided by the incumbent without any competition for the market. Typically, the service provider in these cases is *DB Regio*, a subsidiary of *Deutsche Bahn AG*, the successor of the former state monopolist; in much rarer cases, some other company carries out the service without having obtained the franchise in a competitive fashion.[6]

While DB Regio is still the dominant operator ten years after the reforms were introduced, its competitors, the NE-operators,[7] have expanded their market share from about 3% at the beginning of the reform to 13.2% in 2004 (DB AG 2005).[8] Moreover, in cases where competitive bidding is applied, the competitors are successful at least as often as DB Regio, suggesting that in the medium term this operator's dominance may well belong to the past.[9]

The paper analyzes empirically whether competition for the market has had a positive effect on the performance of passenger railways. We concentrate on the state of Baden-Württemberg, one of the largest German states, where the fraction of railway lines that have been exposed to competition is well above average. Apart from the fact that this restriction in the scope of the analysis simplifies the task of data collection, focusing on one state has the additional advantage of reducing within-sample heterogeneity.

[5] The development of the yearly transfer payments is reported in Deutsche Bahn (2003). Note, however, that only about 70-80% of the payments are devoted exclusively to rail transportation as other modes also obtain support.

[6] As will be laid out in Section 2, a considerable number of small operators were already active before the railway reform.

[7] "NE" refers to "nicht bundeseigen", that is, not belonging to the Federal Republic of Germany. The term contains both privately owned firms and firms that belong to the public sector (e.g., firms that are owned by local authorities).

[8] This market share is expressed in terms of the services supplied (train kilometers). In terms of patronage, the competitors' market share is still below 6%.

[9] It should be noted, however, that there is a recent tendency for agencies to write long-time contracts with *DB Regio* which put limits on the extent to which competitive bidding will be used in the future. For instance, in Baden-Württemberg such a contract was signed in 2003 (Stuttgarter Nachrichten 2003).

Economic theory provides two reasons why it should be possible with competitive bidding to achieve any desired service quality with lower transfer payments. First, competition puts pressure on firms to enter low bids; second, it helps to select the most efficient supplier. The partial introduction of competition in Germany greatly simplifies testing the effects of competition, because we can compare the evolution of the performance on the competitive and the non-competitive segment of the market. However, the data situation is not perfect. Ideally, one would like to use a variable as an efficiency measure that takes both the costs and benefits of providing railway service into account, such as transfer payments per train kilometer or preferably per passenger kilometer. Unfortunately, it is impossible to get data on the evolution of transfer payments at the level of individual lines. Instead, our analysis attempts to clarify whether the development of service quality for the competitively procured lines has been more favorable than for the remaining lines, where service quality is defined as the frequency of service on the railway line under consideration.[10]

Our data strongly suggest that there is a *competition effect*: The quality of service on those lines that were procured competitively developed more favorably than on those that were not. There also appears to be some evidence for ownership effects. On the one hand, NE-operated non-competitive lines tend to grow more rapidly than the corresponding lines operated by *DB Regio*. On the other hand, while the additional effect of competition is strong and significant, for *DB Regio*, it is mixed for the NE-operators. For the largest NE-operator, the Albtalbahn-Verkehrsgesellschaft (AVG) near Karlsruhe, the effect of competition is even stronger, whereas the remaining NE-operators do not develop much differently than their counterparts that did not face competition.

Obviously, the fact that we identify positive competition effects on service quality does not preclude the possibility that the faster growth on the competitively-procured lines arises merely because agencies systematically spent more money on them than the remaining lines. Even though it is not impossible to make such a case, a more likely interpretation is that agencies demand more of the potential contractors when they use competitive bidding than when they face a monopolist, because they are confident that they will get these services for a relatively low level of transfer payments.

Another obvious argument against our conclusion that competition has beneficial effects relates to reverse causality. In principle, agencies may be inclined to procure

[10] See Section 3 for a discussion of this definition.

those lines competitively that have greater growth potential than others.[11] Though we cannot fully rule out this possibility, we try to control for influence factors other than the mode of procurement which might relate to the growth potential of the line. Most importantly, we consider population growth as such a factor. Even though population growth has a modest effect on the change in the frequency of service, including the variable does not lead to a substantial change of our predicted competition effect. This at least provides some support for the notion that the competition effect is not a pure selection effect.

There are further reasons why we do not want to overstate the normative significance of our analysis. Most importantly, we do not analyze whether the level of federal transfer payments that flows into the operation of regional passenger railways (around five billion Euros per year) is adequate from a welfare perspective. Moreover, one might argue that, at least on the more congested lines, additional passenger services take away scarce capacities which are needed for freight or long-distance passenger transportation.[12] However, our analysis is merely concerned with whether competitive procurement is a more effective way of achieving the goal of increasing regional passenger transportation than monopolistic procurement; we do not discuss the goal itself.

The remainder of the paper is organized as follows. In Section 2, we shall sketch some institutional background and develop our hypotheses. Section 3 describes the methods and the data set. In Section 4, we present our econometric results. Section 5 concludes and describes the next steps of the investigation.

[11] Using the telecommunications industry as an example, Duso and Röller (2003) argue that treating policy as exogenous may lead to estimates of competition effects that are biased upwards. Policy endogenity is addressed more generally by Krozner and Strahan (1999) and Besley and Case (2000). Though there is a possibility of endogeneity in our context, the problem is mitigated by the fact that we control for the agencies who take the decisions, so that different political ideologies are unlikely to bias the results.

[12] However, it should be noted that on the majority of lines in our sample there are no severe capacity problems. Though the network in Germany is much less dense than it was in the heydays of railway transportation, there has been no equivalent to the 'Beeching axe' in the UK which led to the closure of most rural low-frequency lines in the nineteen sixties.

2 Background and Hypotheses

2.1 Institutional Background

As in most other European countries, the railways in post-war Germany were essentially run by state monopolies until the early nineteen nineties. In West Germany, *Deutsche Bundesbahn* owned most of the infrastructure and, at the same time, was the dominant operator for passenger and freight services. In addition, there were several minor railroad companies (*NE-Bahnen*) that were typically also vertically integrated and carried out freight and/or passenger transportation on small networks. In East Germany, *Deutsche Reichsbahn* was the integrated operator of the railway system.

Major reforms of the railway system were introduced in Germany in the nineteen nineties. These reforms were induced by the EU-directive 91/440, but there was also some internal pressure to introduce changes to the system. First, after reunification, there was the obvious issue of integrating the East and West German railways. Second, the cumulated debt of the two state railways was immense, amounting to DM 67 Mrd. in 1993 (Greffrath and Lingenthal 1994).

On January 1, 1994, the railway reform became effective. Apart from creating *Deutsche Bahn AG* as a successor of *Deutsche Bundesbahn* and *Deutsche Reichsbahn*, the reform had several elements that were familiar from other countries. First, though *Deutsche Bahn AG* is generally regarded as a vertically integrated company, distinct sub-organisations were introduced at the upstream level (*DB Netz* for the network and *DB Station & Service* for the stations) and the downstream level (*DB Regio* for regional passenger transportation, *DB Reise und Touristik* for long-distance passenger services and *DB Cargo* for freight). Thus, at least a move into the direction of vertical separation was made.[13] Second, even though the infrastructure is still mostly operated by the former state monopolist, some degree of competition was introduced on the downstream sector. Infrastructure owners, in particular *DB Netz,* are required to allow freight operators and long-distance passenger operators access onto their network.[14] With respect to local passenger services, an entirely different avenue was pursued. Essentially, the reforms led to the introduction of

[13] In 1999, this separation was taken one step further. Deutsche Bahn AG then became a holding company, consisting of five corporations.

[14] In practice, access is negligible for long-distance passenger trains, but substantial for freight trains.

competition for the market.[15]

More specifically, as a consequence of the railway reform, the *Länder* have created agencies whose task it is to procure local passenger services. In Baden-Württemberg, the most important agency is the *Nahverkehrsgesellschaft Baden-Württemberg* (NVBW); in addition, the *Verkehrsverbund Rhein-Neckar* (VRN) and the *Verkehrs- und Tarifverbund Raum Stuttgart* (VVS) are in charge of the services in the agglomerations of Heidelberg/Mannheim and Stuttgart, respectively.

These agencies have considerable freedom in the way that they procure services. At one extreme, they can still negotiate directly with the incumbent supplier, without contacting any potential competitors. At the other extreme, they can resort to a formal tender. The extent to which this possibility is used varies considerably across agencies and so do the details of the procedure. In the simplest case, the agency specifies detailed requirements about the level of service quality that it expects. The specifications include the frequency of service, the rolling stock, the prices charged to customers, etc.[16] The contractors' bids are the subsidy levels required to carry out the expected services.[17] The successful bidder receives his required transfer and obtains the franchise for a period of typically 5-10 years. He then becomes the residual claimant for the operating profits of the line.[18]

Differences in contractors' bids reflect both differences in their relative efficiencies and in the quality of the estimations of the value of the franchise, which is driven for instance by the expected number of passengers. Thus, the auction has a private-value component as well as a common-value component. For this reason, it is not necessarily clear that the successful bid will come from the most efficient firm. The winner may simply have overestimated the potential gains from the market. To our knowledge, there is only one obvious case of competitive bidding in the German

[15] Competition for the passenger market also plays a role in Sweden and the U.K. and to a much lesser extent in the Netherlands.

[16] In Germany, regional public transport organisations (*Verkehrsverbünde*) coordinate timetables, prices etc. on a substantial part of the network. In some cases, but my no means always, these organisations are identical with the agencies that procure services; often they are entirely separate institutions. Either way, the freedom of railway operators to set prices is limited by the existence of the public transport organisations.

[17] In typical textbook treatments of competition for the market (Viscusi et al. 2000), the procedure is slightly different. Contractors do not bid the required subsidy. Instead, they bid the price they want to charge to consumers and the lowest bid wins (Demsetz 1968).

[18] There are also cases where the specifications of the auction are less detailed, leaving some scope for the contractors to compete in other dimensions than the required subsidies. As the exact weighting of the different dimensions is typically left unspecified, the allocation mechanism is closer to a "beauty contest" than to multi-dimensional auction in the sense of Che (1993) and Branco (1997).

railway market where this kind of "winner's curse" phenomenon played an important role: The winner of an auction for the line Hamburg-Flensburg in Schleswig-Holstein was the newly founded *FlexVerkehrs AG* that went bankrupt within a year after taking up the service in 2002 (derFahrgast 2003).[19]

As a result of the introduction of competition for the market, the market share of DB Regio's competitors has grown substantially. The pool of competitors consists of several types of firms. First, the above-mentioned pre-reform NE-operators play an important role. These firms typically still own their old infrastructure, but they often have expanded their operations onto the network of Deutsche Bahn where they are exclusively responsible for the provision of downstream services.[20] Second, some entirely new companies have been formed. Third, some railway operators are joint ventures between other companies, in some cases including *DB Regio*.[21] Finally, foreign firms have entered the market. Typically, they have taken over independent local operators; however, there are also examples of entry on lines that were previously operated by *DB Regio*.[22]

2.2 Hypotheses

In the following, we shall show empirically that competitive procurement has a positive effect on a suitable measure of service quality. Though we shall be more specific in the empirical analysis, it is useful for the moment to think of service quality in a very broad way, including the frequency of service, reliability, comfort and, in addition, ticket prices, which are often part of the arrangement between agencies and contractors.

[19] A related case concerns the important line Hamburg-Westerland, also in Schleswig-Holstein. Here, the successful *Nord-Ostseebahn* entered a very attractive bid, but apparently finds it difficult to break even. As a remedy, it is playing with the idea of increasing ticket prices for some passengers (Hamburger Abendblatt, 14/10/2005).

[20] In Baden-Württemberg, the main pre-reform operators were *Südwestdeutsche Eisenbahngesellschaft* (SWEG), *Württembergische Eisenbahngesellschaft* (WEG), *Hohenzollerische Landeseisenbahn* (HzL), *Albtalbahn-Verkehrsgesellschaft* (AVG) and *Oberrheinische Eisenbahngesellschaft* (OEG). SWEG, HzL and AVG have expanded their operations onto the Deutsche Bahn network, partly in joint ventures. OEG still concentrates on its old network; WEG has been taken over by *Connex.*

[21] In Baden-Württemberg, there are no examples of entirely new firms in the market. However, for instance, the *Breisgau S-Bahn* was founded jointly by SWEG and the *Freiburger Verkehrs AG,* the municipal transportation firm in Freiburg.

[22] An example of the former case is *Connex*, a multinational company based in France; an example of the latter case is the entry of Swiss firms on lines near the border: the state railway SBB near Basel and its subsidiary *Eurothurbo* near Lake Constance.

To justify our hypotheses, it is useful to sketch a reduced-form model which captures the essence of our argument. We think of the agency as procuring services either by direct negotiations or by competitive procurement. In either case, suppose the agency wants to procure a service level of q. For simplicity, suppose further that the marginal costs of procuring the services are constant. The service can be provided by the incumbent whose costs of providing service level q are $C_1(q) = c_1 q$, and by potential entrants $i \in \{2, ..., I\}$ with corresponding cost functions $C_i(q) = c_i q$. However, in the case of *direct negotiations*, the agency does not take the possibility of procuring the service from the potential entrants into account. Suppose the agency has imperfect information about the costs of the incumbent. Then, without specifying the details of the negotiation game, we make the following assumption about the outcome.

Assumption 1 *In the case of direct negotiations, the transfer $t^N(c_1)$ paid to the train operator per unit of service satisfies*

$$t^N(c_1) > c_1,$$

where $t^N(c_1)$ is a strictly decreasing function.

There are many conceivable game structures that lead to this implication, but we refrain from spelling out the details. Intuitively, when there are direct negotiations with the incumbent supplier, there is usually no immediate threat for the supplier that asking for high transfers will mean losing the contract; also the incumbent benefits from asymmetric information about costs. Thus, the incumbent can be expected to have some bargaining power vis à vis the agency, reesulting in positive rents.

Under *competitive procurement*, the agency faces the entire set of firms. We continue to suppose that the cost distribution is imperfectly known. Again, we do not specify the details of the mechanism by which the operator and the transfer level are determined, but we make the following assumption.

Assumption 2 *In the case of competitive procurement, the service is carried out by the operator with the lowest cost level c_i. The transfer $t^A(c_1, ..., c_I)$ paid to the train operator per unit of service is a decreasing function of $(c_1, ..., c_I)$ satisfying*

$$t^N(\min\{c_1, ..., c_I\}) > t^A(c_1, ..., c_I).$$

Intuitively, the mechanism selects the lowest-cost operator, and competition forces him to ask for lower transfers than he would have obtained in the case of direct negotiations. Therefore, compared with the case of direct negotiations, there are two reasons why the required transfers are lower. First, there is the *efficiency effect*: Except when the incumbent has the lowest cost level, competitive bidding helps to select a more efficient firm. This effect is captured by the difference between $t^N(c_1)$ and $t^N(\min\{c_1, ..., c_I\})$. [23] In addition, there is the *competitive-pressure* effect that all firms, whether incumbents or not, are forced to take the existence of competitors into account. This effect corresponds to the difference between $t^N(\min\{c_1, ..., c_I\})$ and $t^A(c_1, ..., c_I)$.

Figure 1 summarizes the implications of Assumptions 1 and 2, showing how the introduction of competition improves the position of the agency. The line denoted 'Monopoly' contains all feasible combinations of transfers ('subsidies') and quality for an agent facing a monopolist; the line 'Competition' is the analogous line for an agent that has introduced competition. Both lines are increasing, as higher quality will require higher transfers. However, the line 'Competition' lies below line 'Monopoly' to capture the hypothesis that competition reduces the required transfers.[24]

In principle, there are three distinct possibilities for the agency to reap the harvest of competition. Relative to the Status Quo (SQ), the agency could obtain:

1. higher quality, lower transfers (Point A)
2. lower quality, much lower transfers (Point B)
3. much higher quality, higher transfers (Point C)

Without further assumptions about the agency's objective, it is not clear whether it opts for an improvement of the quality of supply after the introduction of competition, that is, whether one of the cases A or C will obtain. Clearly, however, the agency possesses the option to improve quality without necessarily having to resort to higher transfers.

To see why possibilities B or C are plausible outcomes, it is helpful to think of the agency as representing a state that can spend a fixed budget on railway services

[23] However, as procurement auctions typically have private and common value components, relatively inefficient firms may win the bid when the uncertainty about the common value is large (see, e.g., Goeree and Offerman 2003 for a more thorough analysis).

[24] The fact that the monopoly line lies above the competition line is the only important aspect of the Figure; neither the linearity nor the difference in slope is relevant for our discussion.

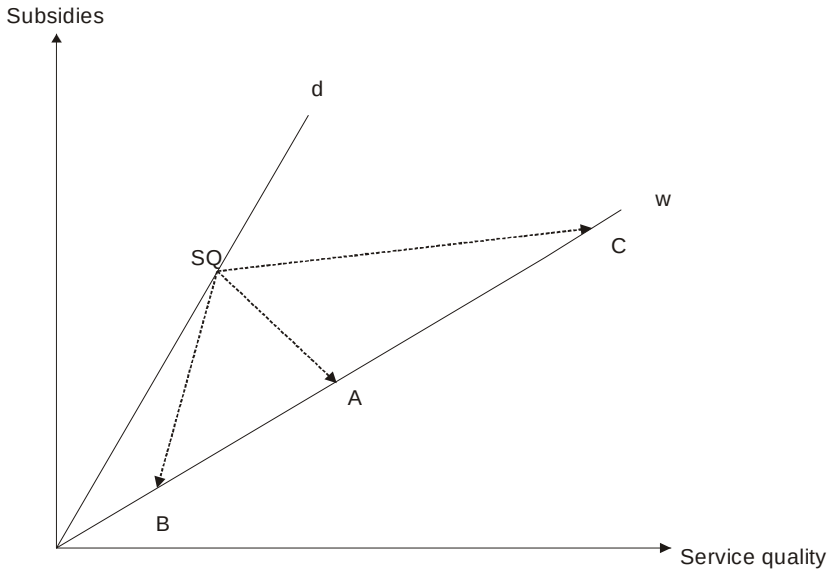

Figure 1: Feasible subsidy/quality-bundles

and other goods. Under assumptions 1 and 2, the price of railway services relative to other goods decreases. Even so it is not strictly speaking necessary that the agency chooses to ask for a greater level of service quality under these circumstances, both the substitution effect and the income effect of this change make it more attractive to do so.

Thus, we formulate the main hypothesis of this paper:

Hypothesis 1 *Competition increases service quality.*

This hypothesis does not necessarily presuppose that the competitors are more efficient than the incumbent. Competitive pressure alone forces DB Regio to improve its offer so that it wins the bid: In cases where DB Regio is the incumbent and has lower costs then the entrants, $\min\{c_1, ..., c_I\} = c_1$ so that the agency's gain from introducing competition is

$$t^A(c_1, ..., c_I) - t^N(\min\{c_1, ..., c_I\}) = t^A(c_1, ..., c_I) - t^N(c_1).$$

When the incumbent is not the lowest-cost firm, the gains from competion are

$$t^A(c_1, ..., c_I) - t^N(\min\{c_1, ..., c_I\}) > t^A(c_1, ..., c_I) - t^N(c_1).$$

Now suppose that, even though the agency is not perfectly informed about the cost structure, it has some ex-ante information about the relative costs of different

firms, which translates into information about who is most likely to win the auction.[25] Then, in situations where the agency expects entrants to have lower costs than the incumbent, the agency should expect greater decreases in costs per unit of service than in cases where the agency expects the incumbent to have lowest costs. Therefore, it also seems plausible that the agency demands more quality in the former case than in the latter.

Hypothesis 2 *Other things equal, the difference in service levels demanded by the agency under direct negotiations and competitive procurement is higher when competition leads to an ownership change than when it does not.*

Thus our investigation of the two hypotheses can also be regarded as an attempt to contribute to the clarification of the open question whether competition or ownership is decisive for quality improvements in the public sector (Vickers and Yarrow 1988, ch. 1).

3 Data and Methods

To test our hypotheses, we first require a measure of service quality. Ideally, such a measure should aggregate all relevant aspects of quality, that is, the frequency of service, safety, comfort and prices. A good candidate for such a measure would be the number of passenger kilometers traveled on a line. This measure reflects the conceived service quality from the perspective of the passengers. Unfortunately, however, we only have rudimentary data on passenger kilometers, so that we used a less satisfactory measure, namely the *frequency of service*. We measure this frequency as the ratio between train kilometers per year (tkm) and the length of a line (lkm).[26] The frequency of service is an important aspect of service quality, but obviously not the only one.

To identify competition effects, we compare the evolution of the frequency of service in the group of competitive lines and the control group. We first introduce a definition for a competitively served line. To understand this definition, it is important to note that agencies do not necessarily procure all services on one line in the same fashion. For instance, in some cases, the agencies use competitive bidding

[25] For instance, suppose it can order the cost distributions of the firms by first-order stochastic dominance.

[26] Thus, the frequency of service corresponds to the average number of trains per year on each kilometer of tracks.

for higher-level services (*Regionalexpress),* but procure lower level services on the same level directly from the monopolist.

Definition 1 *A line is* ***served competitively*** *if, for at least 20% of the train kilometers that were provided on these lines in the year 2003/2004, one of the following conditions holds:*
(i) The services were procured using a formal tender.
(ii) The services were procured on the basis of offers from at least two firms that were approached directly by the agency.[27]
(iii) Apart from the incumbent, at least one firm offered a contract to the agency without having been asked to do so.
(iv) For reasons other than those given under (i)-(iii), the services were carried out by another firm than the former incumbent DB Regio.

Case (i) is the most important. The largest auction in Germany to date was carried out by VRN. *DB Regio* cast the successful bid for the *S-Bahn Rhein-Neckar*, a new metro system in the Heidelberg-Mannheim agglomeration, amounting to approximately 6 Mio. tkm per year (Die Welt 2001). Other major cases of competitive bidding in Baden-Württemberg included metro lines near Freiburg, Karlsruhe and Offenburg and the *Ringzug,* involving 1.258 Mio. tkm per year in the eastern part of the Black Forest (Hohenzollerische Landesbahn 2001).

Case (ii) is quite common in general, but not in Baden-Württemberg.[28]

Case (iii) is rare in general, but it happened in Baden-Württemberg on one occasion: Starting from 2003, the lines Basel SBB – Zell im Wiesental and Weil am Rhein – Stetten were initially supposed to be served by the incumbent *DB Regio* jointly with SBB, the Swiss state railway company. Then SWEG submitted an unsolicited bid for both lines to which SBB reacted by submitting a bid without *DB Regio* (Wirtschafts- und Sozialdepartement Basel-Stadt 2002).

We included category (iv) because it appears plausible that a firm that takes over the duty of operating a line instead of *DB Regio* believes it can carry out the service more efficiently than the incumbent. A typical example is the line Schorndorf-Rudersberg near Stuttgart. In 1996, this line was "sold" for DM 1.-

[27] *The 20% cut-off value to identify competitively procured lines is somewhat arbitrary; as, on most lines, the following conditions (i)-(iv) hold either for a very small number of services or for a large number of services, the results are likely to be robust to the exact choice of the cut-off level.*

[28] For instance, in nearby Bavaria, the agency *Bayerische Eisenbahngesellschaft* asked five operators directly to submit bids for about 1 Mio tkm on the line Munich-Oberstdorf (Bayerisches Staatsministerium 2003).

Table 1: Local Passenger Lines in Baden-Württemberg

	Number	Percentage of Lines	Line-Kilometers	Percentage of Line-Kilometers
Without competition	52	65	2478	61
With competition	28	35	1565	39
Total	80	100	4043	100

from the infrastructure operator *DB Netz* to the *Württembergische Eisenbahngesellschaft (WEG)* which now belongs to the *Connex* group. The new infrastructure owner also carries out the services on this line.[29]

Finally, we should point out that the group of competitive lines was not exclusively served by competitors of *DB Regio* in the year 2004. When the incumbent *DB Regio* won the bid, the line was obviously also included in the category of competitively served lines.

We first start with a simple descriptive approach to the problem. To identify the effect of competition, we compare the difference between the distribution of the frequency of service on the competitively served lines in 2004 and 1994 with the corresponding frequencies for the control group. Essentially, we speak of a positive competition effect when the growth in the frequency of service is larger in the competitive group than in the control group. Underlying this approach is the assumption that, without the introduction of competition, there would have been no systematic difference between the evolution of lines in the competitive group and those in the control group. However, the approach does not require the initial distribution of frequencies in the two groups to be similar.

For the simplest version of our investigation, we require the following information:

(1) A division of the passenger railway network in Baden-Württemberg into disjoint lines.

(2) The length of each line.

(3) The total train kilometers for each line in the years 1993/94 and 2003/04.

[29] In this example and several related cases, the new operator is vertically integrated, which is typically not the case in the other examples. There, the infrastructure is owned by *DB Netz*, whereas the services are provided by other firms (except when *DB Regio* is the successful bidder).

Table 2: The Evolution of the Market (Overview)

	1994	2004	%-change
Total tkm (/1000)	65857	85255	29
tkm on lines without competition (/1000)	43769	53199	22
tkm on lines with competition (/1000)	22089	32057	45
tkm with competition (%)	34	38	12
number of NE-lines	19	39	105
percentage of NE-lines	24	49	105
lkm on which NE-operators are active	719	1888	163
% of lkm on which NE-operators are active	18	47	163
number of AVG lines	3	12	300
tkm supplied by AVG (/1000)	3839	15386	301

Notes: NE refers to all operators except Deutsche Bahn (DB). AVG is a NE operator.

(4) For each line, information on whether it belongs to the competitive group or to the control group.

Items (1)-(3) were calculated from DB timetables, which involved substantial effort. We included those lines that were predominantly in the influence sphere of the agencies NVBW, VRN and VVS.[30] The division of the network into lines follows the 2004 timetable. Some adjustments were necessary, however, to avoid double-counting of trains. Lines that were closed down between 1994 and 2004 were not included.

Table 1 summarizes the data. There are 80 lines, 28 of which belong to the competitive category. In terms of length, 39% of the network are served competitively.[31]

Next, we consider the evolution of frequencies between 1994 and 2004. From Table 2, we observe:

1. a 29% increase in total transportation

2. a much stronger increase in the competitive group (45% vs. 22% in the control group);

3. an increase in the number of lines operated at least partly by competitors of DB Regio from 19 to 39.

[30] A small number of these lines lies partly outside of Baden-Württemberg.

[31] Recall that on competitively served lines, not all the services are necessarily procured in a competitive fashion.

Table 3: Frequency of Service (Service quality)

	1994	2004
10th percentile	6.045	6.784
Median	12.815	17.367
90th percentile	28.827	49.413
mean	16.015	21.963
standard deviation	12.145	15.508
Number of lines	80	80

The aggregate results in Table 2 suggest an increasing importance of competitive procurement mechanisms. It is unclear, however, whether this effect merely reflects that a growing number of lines have been exposed to competition or whether the lines that have been subjected to competition have actually grown faster than others.

4 Results

We now present our main observations about the evolution of the frequency of service. Before describing the estimation results, we present our results using simple tables and figures.

4.1 Descriptive Statistics

First, we describe the evolution of total transportation.

Result 1 *In the period under consideration, the frequency of service in Baden-Württemberg has increased substantially.*

Table 3 compares the main indicators of the distribution of the frequency of service for 1994 and 2004. The table shows a clear increase in the various percentiles and the mean.

Figure 2 confirms this result. It shows that the density function for the frequency of service has moved to the right between 1994 and 2004.[32]

[32] Here and in the following, the graphs were obtained using Epanechnikov kernel density estimators (with bandwidth $h = 0.9\widehat{\sigma}n^{-1.5}$, where n is the number of observations, $\widehat{\sigma} = \min\left\{S, \frac{IQR}{1.349}\right\}$, S is the standard deviation and IQR the interquartile range).

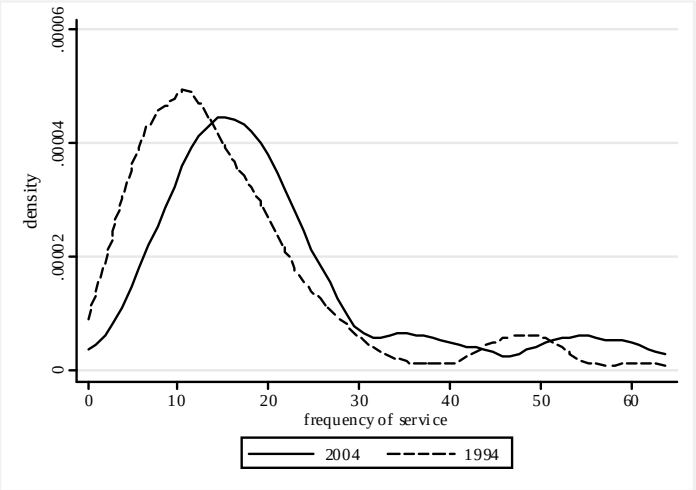

Figure 2: The change in the frequency of services (1994 vs. 2004)

Obviously, the change between 1994 and 2004 only reflects an expansive policy; in itself, it says nothing about an effect of competition. Figures 3 and 4 are more helpful in this respect. Figure 3 compares the estimated densities of the frequency of services for the competitive group and the control group in 2004. The figure suggests the following result.

Result 2 *The frequency of services in the competitive group was higher than in the control group in 2004.*

The result corresponds to the observation that the density for the competitive group lies further to the right than for the control group. Obviously, this observation does not necessarily imply a competition effect in itself. It is conceivable that it merely reflects a selection effect, namely that more attractive lines are exposed to competition more often than less attractive lines. In the concrete example, this natural suspicion turns out to be unjustified, even though on a considerable fraction of lines in the competitive group the frequency of service in 1994 was already substantial, for instance on those lines that were subjected to the competitive bidding for the Rhein-Neckar metro system or on most of the lines that were taken over by the *Albtalbahn-Verkehrsgesellschaft (AVG)* in the Karlsruhe area. This effect was counterbalanced by the fact that many lines in the competitive group had a very low frequency of service in 1994. The most spectacular example is the line from Schorndorf to Rudersberg, on which *DB Regio* supplied only 4607 tkm/lkm in 1994, while *Connex* supplied 15.558 tkm/lkm in 2004.

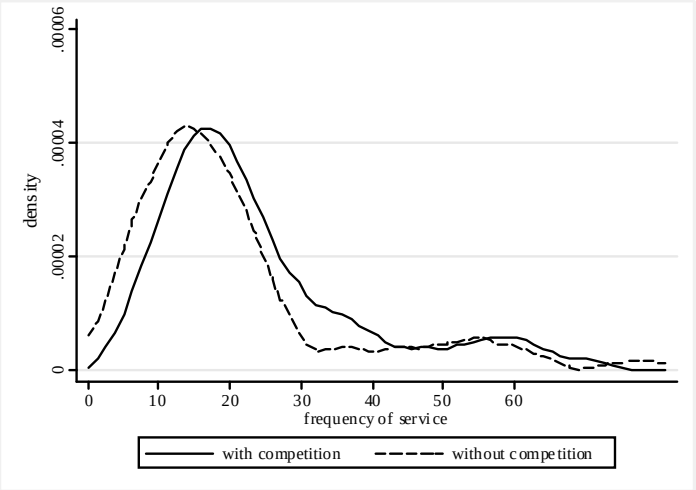

Figure 3: The frequency of services on competitive and non-competitive lines (2004)

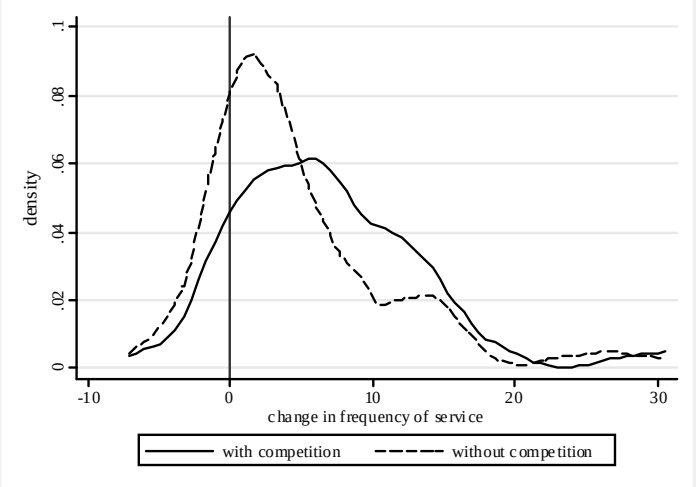

Figure 4: Change in the frequency of services on competitive and non-competitive lines

Figure 4 displays the densities of the change in the frequencies of service between 1994 and 2004 for the competitive and non-competitive lines. Clearly, competitive procurement corresponded to higher growth in service quality. This means that competitive lines were not characterized by higher service quality in 1994. Rather, the fact that the frequency of service is higher on competitive lines compared to non-competitive lines appears to be a competition effect.

Result 3 *On lines that were exposed to competition between 1994 and 2004, the frequency of services grew more strongly than in the control group.*

As argued earlier, we interpret this as a competition effect. When faced with a set of potential contractors rather than with a monopolist, agencies can ask for better service quality without necessarily having to pay high transfers.

Several caveats concerning this interpretation are in order. First, from a theoretical point of view, one might ask why agencies do not apply the competitive mechanism more often if it is so successful. One explanation might be that there is value to experimentation with a relatively unfamiliar allocation mechanism. Also, a competitive tender almost certainly involves higher transaction cost than direct negotiations.[33] Second, it is worth bearing in mind that our analysis lacks subsidy data. Thus, we cannot provide evidence for greater "value for money" in the procurement of railroad services. For instance, if for some reasons agencies associate service quality with competition, they might simultaneously opt for competitive procurement and high transfers on lines that they want to expand, whereas they procure from the incumbent on lines where they want to keep low service levels, which makes low transfers possible.

5 Econometric Analysis

In the following, we shall investigate whether the competition effect suggested by Result 3 survives under closer scrutiny. We shall first analyze more carefully whether the lines subjected to competition are different from the lines in the control group. We shall then use these insights to carry out an econometric analysis of the determinants of the change in service quality. Finally, we consider the effects of ownership.

[33] Alternatively, one could cook up political-economy stories about regulatory capture of the agencies by the former state monopolist.

5.1 Selection of Competitive Lines

Observers of the German railway industry frequently complain that the lines that are procured competitively tend to be "lemons", that is, unattractive lines with low service quality and low growth prospects. Our descriptive analysis in the last section suggests that this is not true for the special case of Baden-Württemberg. Nevertheless, we now analyze more carefully whether the lines in the treatment group are indeed systematically different from those in the control group.

Most of our explanatory variables relate to the attractiveness of the lines, which is mostly determined by geography. Specifically we consider the geographic distance to the nearest city with at least 100,000 inhabitants as a measure of remoteness. Further, we include the size of both the biggest and the second-biggest city in 1994. Next, importantly, we consider the population growth between 1994 and 2004 in the two major cities. If there is a systematic trend difference between lines in the competition group and the remaining lines which leads agencies to ask for a greater service increase in the former group than in the latter, this could well be reflected in population growth.

In addition, we include a dummy variable to check whether a line is electrified or not. The prime motivation for doing so is that electrified lines are likely to be more attractive than lines that are not. Also, one might imagine that agencies are more reluctant to subject electric lines to competition because one would imagine that successful bidding by entrants is less likely on these lines. Finally, we include three agency dummies, taking values of one when the line in question is procured exclusively by one of the three agencies; the reference case where all agency dummies are zero thus relates to the situation that several agencies procure the services.

Table 4 gives simple descriptive statistics. The results suggest that there is little reason to believe that lines with competition are systematically less attractive than lines without competition in terms of exogenous characteristics. On the one hand, the lines in the former group tend to be somewhat less attractive in the sense that they are less populated and show less population growth. On the other hand, the competitive lines tend to be less remote, and a much greater percentage of the lines in the competition group is electrified (64.3 as opposed to 48.1% in the control group). A probit analysis reported in Table A1 in the Appendix gives a similar picture.

We should hasten to add that the picture presented here is likely to be specific to Baden-Württemberg, where in essentially all of the major cities a substantial part of the "S-Bahn" (Metro) traffic is procured competitively. This is highly unusual

Table 4: Characteristics of Lines by Competition Status in 2004

	With competition	Without competition	Difference (abs z-Value)
Distance to nearest city (km)	7.857	18.135	-10.277
			(-1.838)
Population in community 1 (1994; 1000)	166.640	214.781	-48.141
			(-1.017)
Population in community 2 (1994; 1000)	41.614	52.099	-10.485
			(-0.774)
Population growth in community 1 (%)	2.400	2.970	-0.570
			(-0.585)
Population growth in community 2 (%)	3.475	3.446	0.029
			(0.029)
Electricity	0.643	0.481	0.162
			(1.386)
Length (km)	55.893	47.654	8.239
			(0.863)
Agency (Other)			
VVS	0.036	0.115	-0.080
			(-1.199)
VRN	0.179	0.212	-0.033
			(-0.348)
NVBW	0.571	0.442	0.129
			(1.097)
Lines	28	52	

Notes: Community 1 is the largest community, and community 2 is the second largest community along the railway line.

in the rest of Germany, where there seems to be clearer evidence for the "lemons"-hypothesis.

The results in Table 5 extend the point just made, and they cast even more doubt on the idea that lines in the competition group are systematically less attractive than lines in the control group. The results allow us to understand what the explanatory variables just discussed have to say about differences in ex-ante service quality. The first column in the table shows that there is hardly any ex-ante difference between lines with and without competition. The second column uses the additional independent variables discussed in Table 4 as controls. After introducing them, there is a mild tendency in the direction that competitive lines are slightly more attractive than those in the control group, but this tendency is weak.

Also, the effects of the additional controls on ex-ante service quality are plausible. First, the significant coefficients suggest that electrified lines and lines that are in the agglomerations of Stuttgart (VVS) and Heidelberg-Mannheim (VRN) have substan-

tially higher service quality. Second, though the population-related variables are not significant individually, they are jointly significant, and their effect is plausible: The greater the population of each of the two biggest cities on the line, the higher the ex-ante service quality. Also, the role of the interaction term between population in community 1 and the length of the line is interesting. Though the coefficient is not significant, it suggests that the influence of the population in the largest community on service quality is smaller when the line is longer. This clearly corresponds to intuition: A line that connects the largest city in the country, Stuttgart, with some remote part of the Black Forest should be expected to be served less than a line that lies almost entirely in the agglomeration.

Summing up, there is no selection effect of competitively procured lines with respect to the characteristics we observe. In a similar vein, the competitively procured lines are not systematically different from the control group in terms of the service quality before the introduction of competition. This is evidence in favor of our main identifying assumption that lines with competition would have involved in much the same way as lines without competition if they had not been subjected to competitive bidding.

5.2 Competition Effects

We now use the control variables just introduced to explain the differences in the changes in service quality better. Table 6 contains the results. The first column essentially restates our earlier observation of a positive competition effect (Result 4). The remaining columns show the effects of introducing control variables.

Consider the second column. Most importantly, lines with high initial population in the largest community experience higher growth, and this effect is more pronounced for shorter lines. The remaining coefficients are insignificant. By adding two variables relating to the population growth in the biggest and second-biggest city, the model presented in Column 3 deals with the conjecture that changes in the service quality demanded by the agencies may reflect actual and expected population changes. Though indeed service quality seems to grow slightly more rapidly on the lines expecting greater population growth, the effect is both insignificant and negligible in size.[34]

[34] A one percentage point increase in population growth is associated with an increase in service quality of 99 train kilometers per line kilometer.

Table 5: Explaining ex ante differences in Service quality
Dependent variable: Service quality in 1994

With competition	0.040	0.936
	(0.02)	(0.35)
Distance to nearest city (km)	-	-0.034
		(0.86)
Population in community 1 (1994; 1000 inhabitants)	-	0.023
		(1.21)
Population in community 2 (1994; 1000 inhabitants)	-	0.036
		(1.51)
Pop. in comm. 1 * length (/100)	-	-1.046
		(0.57)
Electricity	-	4.807
		(1.71)*
Length (km)	-	0.017
		(0.59)
Agency (Other)		
VVS		15.026
		(2.19)**
VRN		9.214
		(2.88)***
NVBW		4.705
		(1.83)*
Constant	16.001	2.268
	(8.54)***	(0.61)
F-test, pop. in comm. 1 and 2	-	2.72*
Observations	80	80
R-squared	0.00	0.44

Notes: Absolute z-Value in parentheses (based on robust Huber-White standard errors). * significant at 10%; ** significant at 5%; *** significant at 1%. Service quality is train kilometers per line kilometers.

Table 6: The effect of competition on Service quality
Dependent variable: Change in Service quality 1994 to 2004

With competition	3.319	3.758	3.825
	(1.77)*	(2.20)**	(2.20)**
Distance to nearest city (km)	-	0.022	0.024
		(0.83)	(0.89)
Population in community 1 (1994; 1000 inhabitants)	-	0.021	0.022
		(2.18)**	(2.28)**
Population in community 2 (1994; 1000 inhabitants)	-	-0.003	-0.001
		(0.14)	(0.03)
Pop. in comm. 1 * length (/100)	-	-0.015	-0.017
		(1.42)	(1.49)
Electricity	-	2.356	2.518
		(1.40)	(1.54)
Length (km)	-	-0.025	-0.020
		(1.08)	(0.83)
Agency (Other)			
VVS	-	-5.049	-5.572
		(1.30)	(1.34)
VRN	-	-0.468	-0.291
		(0.14)	(0.09)
NVBW	-	-1.062	-1.250
		(0.39)	(0.45)
Population growth in community 1	-	-	0.099
			(0.63)
Population growth in community 2	-	-	0.119
			(0.80)
Constant	4.786	3.233	1.245
	(5.19)***	(1.03)	(0.44)
F-test, pop. in comm. 1 and 2	-	2.45*	2.73**
Observations	80	80	80
R-squared	0.04	0.25	0.27

Notes: Absolute z-Value in parenthese (based on robust Huber-White standard errors).

As the first row of Table 6 clearly shows, both of the extended models suggest that the competition effect is remarkably robust, with the size and significance of the competition coefficent being almost unchanged in the three different models.[35]

5.3 Ownership Effects

The results sketched so far suggest a positive competition effect. However, we have not yet shown whether this effect is driven by ownership or by competitive pressure. Out of the 28 lines subject to competitive bidding, 8 lines were won by DB Regio, 7 lines were won by AVG – the largest NE-operator in Baden-Württemberg that operates in the Karlsruhe area– and the remaining 13 lines were won by smaller NE-operators. Thus, it is not clear whether a change of ownership from DB Regio to an NE-operator is necessary for an improvement in service quality.[36]

Table 7 is a first step towards disentangling the effects of competition and ownership. The left-hand column is identical with the last column in Table 6, that is, there are no controls for ownership. The right-hand column controls for ownership. The reference case is a line operated by *DB Regio* in 2004. In addition, we use two dummies to distinguish between two types of NE lines, those operated by AVG and those run by the remaining NE lines. The motivation for doing so is that the AVG is a particularly large operator, the expansion of which was pushed by local policy.

[35] Note that inference is based on Huber-White standard errors. We have also examined inference based on standard errors clustered at the agency level. These standard errors are smaller than the standard errors reported in Table 6. In order to perform a conservative test of significance of the competition effect, we base inference on standard errors that do not allow for clustering at the agency level.

[36] Given the small size of our sample and specifically the fact that there are only 28 members of the competition group, it is impossible to draw far-reaching conclusions about the relation between ownership and performance. However, the following observations suggest why such an analysis might be instructive at the national level.

Table 7: Competition vs. ownership
Dependent variable: Change in Service quality 1994 to 2004

With competition		3.825	3.595
		(2.20)**	(1.94)*
With competition * operated by AVG		-	6.851
			(1.30)
With competition* operated by other NE (excl. AVG)		-	-3.687
			(1.20)
Distance to nearest city (km)		0.024	0.060
		(0.89)	(1.96)*
Population in community 1 (1994; 1000 inhabitants)		0.022	0.028
		(2.28)**	(2.61)**
Population in community 2 (1994; 1000 inhabitants)		-0.001	0.000
		(0.03)	(0.00)
Pop. in comm. 1 * length (/100)		-0.017	-0.016
		(1.49)	(1.35)
Electricity		2.518	-0.991
		(1.54)	(0.54)
Length (km)		-0.020	-0.008
		(0.83)	(0.33)
Agency (Other)			
	VVS	-5.572	-3.519
		(1.34)	(0.88)
	VRN	-0.291	1.977
		(0.09)	(0.63)
	NVBW	-1.250	-0.963
		(0.45)	(0.37)
Population growth in community 1		0.099	-0.094
		(0.63)	(0.52)
Population growth in community 2		0.119	0.359
		(0.80)	(1.84)*
Operator (DB)			
	AVG	-	4.735
			(1.32)
	NE (excl. AVG)	-	3.642
			(1.23)
Constant		1.245	-1.413
		(0.44)	(0.42)
Observations		80	80
R-squared		0.27	0.39

Notes: Absolute z-Value in parenthese (based on robust Huber-White standard errors). * significant at 10%; ** significant at 5%; *** significant at 1%. Service quality is train kilometers per line

Our results show that is important to take ownership into account. First, the positive signs of the pure ownership dummies (AVG and NE other than AVG) suggest that, in the absence of competition, both types of lines saw stronger growth

than the *DB Regio* lines; note, however, that neither effect is significant. Second, the interaction terms show that competition effects are heterogeneous, though the effects are again not quite significant. For lines operated by *AVG*, the competition effect is much stronger than for the baseline case of DB Regio. For the remaining NE-operators, there is essentially no competition effect.[37] By and large, there is not much support for Hypothesis 2. It does not seem that the competition effect is larger when ownership changes than when it does not.

6 Summary

The preceding results show that there are positive effects of competition for the passenger railway market on service quality. There are several reasons to criticize our approach. For instance, one might argue that the lines in the control group are also subjected to some degree of competition, because *DB Regio* might fear that uncooperative behavior induces the agency to resort to competition in the future, or that it reduces its chances to succeed on the competitive lines. However, this would suggest that our analysis underestimates the effects of competition.

In addition, we are thinking of several other extensions. First, one could extend the analysis to the entire country. This is possible in principle, but labor-intensive. Second, it would be desirable to use alternative quality measures. In particular, we shall try to supplement our analysis at least partly with data on passenger kilometers. This would not only be useful to improve the analysis of the effects of competition on service quality; it would also help to understand more about the relation between supply quality and patronage. At the present, however, we are skeptical about data limitations. Third, we would like to to use efficiency measures rather than pure output measures. From a policy perspective, it would be interesting to use data on transfers per line-kilometer. It will be impossible to obtain data on the changes in transfers at the required geographical level. Nevertheless, some information on the effects of competition can be obtained by exploiting the relation between required transfers and the extent of competitive procurement at the state level.

[37] The positive overall competition effect of 3.595 and the negative effect of -3.687 captured in the interaction term "With competition*NE, excl. AVG" essentially cancel out.

7 Appendix

Table A1: Determinants of Competition (Probit Analysis)
Dependent variable: With competition

	Coeff. (z-Value)	M.E.
Distance to nearest city (km)	-0.023	-0.008
	(1.86)*	
Population in community 1 (1994; 1000 inhabitants)	-0.003	-0.001
	(1.80)*	
Population in community 2 (1994; 1000 inhabitants)	-0.006	-0.002
	(1.60)	
Pop. in comm. 1 * length (/100)	-0.057	-0.020
	(0.27)	
Electricity	1.219	0.407
	(2.85)***	
Length (km)	0.007	0.002
	(1.33)	
Agency (Other)		
VVS	-0.800	-0.229
	(1.06)	
VRN	-0.430	-0.142
	(0.83)	
NVBW	-0.284	-0.101
	(0.62)	
Constant	0.190	
	(0.27)	
Lines	80	
log Likelihood	-41.39	

Notes: Absolute z-Value in parenthese (based on robust Huber-White standard

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