Discussion Paper No. 16-055

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Centre for European
Economic Research

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July 2016

Abstract

We investigate the characteristics of cities gaining access to the German interurban bus network in the first two years following the deregulation of the industry in January 2013. Applying both parametric and semi-parametric survival models, we find strong evidence that the probability of a city to be added to a provider's network not only increases with the mere size of its population but also with further demographic characteristics such as average income or the share of young and old inhabitants. Additionally, while an increasing importance of tourism has a further positive effect, a rising automobile density is imposing a significantly negative impact on the probability of a city to gain access to the network.

JEL Class: R12, R38, R41, L92, C41

Keywords: Urban areas, transport, interurban bus, deregulation, entry, survival analysis

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1 Introduction

The initiation and implementation of deregulation processes in many network industries over the last few decades was accompanied by a substantial amount of research investigating the economic implications of these liberalization polices. Although many ex-post studies – guided by the seminal contributions of Morrison and Winston (1986) and Kahn (1988, 2003) – pick out price- and efficiency-related issues as central themes, there is no doubt that the question of who gains (or loses, respectively) access to the respective services in the first place is an essential – yet underresearched – driver of the overall welfare implications of deregulation initiatives.

In this context, we investigate the characteristics of cities gaining access to the German interurban bus network in the first two years following the deregulation of the industry in January 2013. Applying both parametric and semi-parametric survival models, we find strong evidence that the probability of a city to be added to a provider's network not only increases with the mere size of its population but also with further demographic characteristics such as average income or the share of young and old inhabitants. Additionally, while an increasing importance of tourism has a further positive effect, a rising automobile density is imposing a significantly negative impact on the probability of a city to gain access to the network.

The remainder of this note is structured as follows. Section 2 provides a brief characterization of the deregulation of the German interurban bus industry, followed by the presentation of our empirical analysis in Section 3. Section 4 concludes the note.

2 Deregulation of the German interurban bus industry

In this section, we first describe the essential steps towards the deregulation of the German interurban bus industry (Section 2.1), followed by a characterization of the aggregated entry activities of all interurban bus providers after deregulation (Section 2.2).

2.1 Steps towards deregulation

Since 1931, national bus companies were only allowed to offer regular interurban bus services on routes on which the state-owned German railway company Deutsche Bahn AG (or its predecessors) was unable to provide an acceptable service. Due to the rather dense (intercity) railway network in Germany, the respective law led to only sporadic interurban bus services except for routes to/from former West Berlin, routes to/from airports with no rail connection and international routes.

In parallel to initiatives by the European Commission to liberalize the international carriage of passengers by coach and bus, in 2009, the German government announced plans to liberalize the national German interurban bus industry aiming at increasing both the mobility of citizens with lower income levels – also implying fiercer intermodal competition – as well as the accessibility of smaller cities (with often either no or only local rail access).

Despite several attempts by different lobbying groups to prevent (or at least weaken) any policy action, the German interurban bus industry was deregulated in January 2013 (see also Dürr et al., 2016). According to the new paragraph 42a Personenbeförderungsgesetz (‘Passenger Transportation Act’), national scheduled transport with passenger vehicles is allowed for routes above a distance of 50 kilometers and where no regional rail connection with up to one hour travel time is offered.

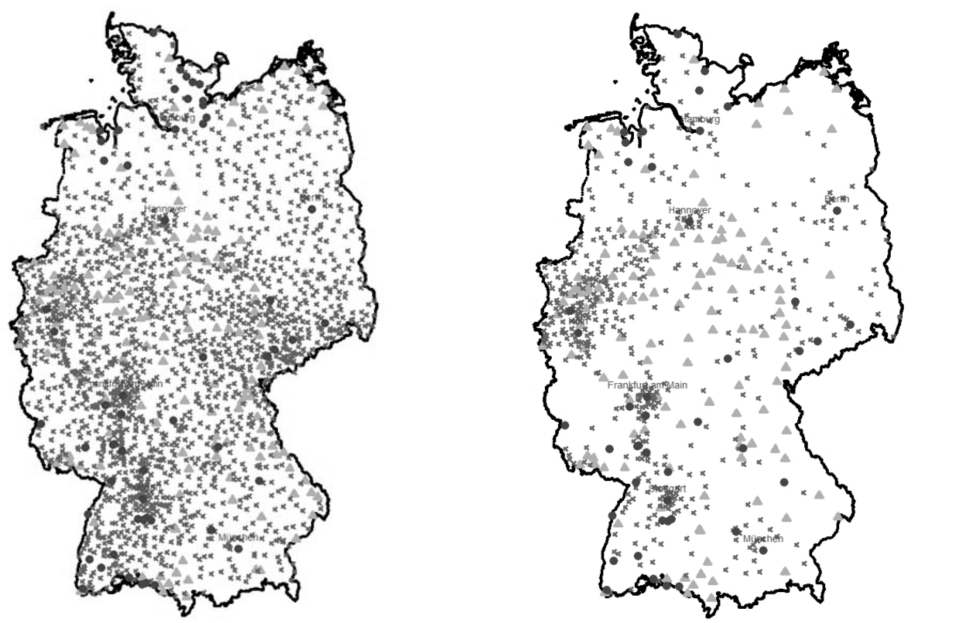
2.2 Entry activity after deregulation

Following deregulation in January 2013, both industry- and route-level entry increased substantially. On the industry level, according to the German Office for Goods Transport (2014, p. 15), the number of operating licenses increased from 86 in December 2012 to 158 in June 2013 and 301 in September 2014 (an overall increase of 350 percent). On the route level, the number of served routes increased from 151 routes in January 2013 to 3,603 routes in December 2014 (an increase of a magnitude of 24).

From a spatial entry perspective, Figure 1 shows both the status of all 2,060 German cities (left-hand chart) and all 644 larger German cities (≥20k inhabitants, right-hand chart) with respect to their access to the interurban bus network. In sum, the number of connected cities increased from 56 cities in January 2013 to 222 cities in December 2014. However, while 97 percent of all large cities (>100k inhabitants) had access to the network, the respective percentages are reduced to 27 percent and 11 percent for medium (≥20k and ≤100k) and small cities (<20k), respectively.

Furthermore, as shown in Figure 1, many larger cities in Germany are characterized by a number of smaller surrounding cities within a radius of about 25 kilometers. As these smaller cities are typically well connected to the local train and bus networks – making it easy to reach the respective large city’s main station – the necessity (an therefore the probability) of including these cities into the interurban bus network is reduced substantially. In our subsequent empirical analysis, we therefore run a specification in which we exclude this type of city from the analysis.

(1) All German cities *(2) All larger German cities (≥ 20k)*



Notes: • *= access in January 2013, Δ = access gained until December 2014, × = no access until December 2014*

Figure 1: German cities and their access to the interurban bus network
Source: own figure based on Simplex Mobility schedule data

3 Empirical analysis

In this section, we present our empirical analysis of the determinants of gaining access to the interurban bus network. While Section 3.1 presents our data set and the summary statistics, Section 3.2 discusses our econometric model and estimation results.

3.1 Data set and summary statistics

Our main data set was provided by Simplex Mobility and consists of all route entries (each between two German cities) by all interurban bus providers from the beginning of the deregulation era in January 2013 to the end of the second year of deregulation in December 2014. In sum, the raw data set includes 3,603 routes providing access to the interurban bus network for 222 German cities (in December 2014).

Aiming at investigating the determinants of a city to gain access to the German interurban bus network, we complement information on our dependent variable (i.e., whether and when a city was connected to the interurban bus network) with a selection of six demographic and three mode-related characteristics (obtained from the Federal Statistical Office and the Federal Office for Building and Regional Planning for the years 2013 and 2014) as explanatory variables. The summary statistics – together with a brief description of the construction of the variables – are presented in Table 1.

Table 1: Variables and summary statistics

Variable	Description	Mean	Std. Dev.	Min.	Max.
Dependent variable					
City connected	=1 if city is connected until 12/14	0.12	0.32	0.00	1.00
Demographic variables					
Population	Overall population in ‘000	33.73	154.53	0.12	3466.16
Income	Average income in ‘000	20.24	2.27	15.78	39.52
Under 24 years	Share of pop. under 24 years	7.35	1.28	4.90	13.50
Over 65 years	Share of pop. over 65 years	21.59	2.43	15.20	28.70
Higher education	Share of pop. with A levels	31.23	8.21	11.80	65.20
Tourism	No. of overnight stays per inhabit.	6.17	7.18	0.50	42.90
Mode characteristics variables					
Motorway distance	Avg. dist. to next motorway, min.	16.00	13.60	0.00	136.00
Automobile density	No. cars per 1000 inhabitants	479.75	208.95	34.06	764.70
IC rail access	=1 if city has intercity rail access	0.12	0.32	0.00	1.00

Without aiming at providing a detailed discussion of all variables shown in Table 1, it exemplarily reveals that about 12 percent of all cities were connected to the interurban bus network until December 2014. The average city has about 33.700 inhabitants, however, with a rather large standard deviation. The average share of younger inhabitants (about 7.4 percent) is substantially smaller than the corresponding share of older inhabitants (about 21.6 percent). On average, an interurban bus station is located 16 minutes away from the next motorway, about 480 cars are available (per 1000 inhabitants) and about 12 percent of all German cities have intercity rail access on a regular basis.

3.2 Econometric model and estimation results

In answering our main research question, we apply parametric and semi-parametric models of survival analysis – a common tool to analyze the time until the occurrence of an event. In our case, this event is the point in time at which a city is connected to the interurban bus network. Both model types are applied to the three different sub-sets of cities introduced above: all cities, all larger cities above 20k inhabitants, and all larger cities above 20k inhabitants but excluding cities within a 25 kilometer radius around large cities (>100k).

Table 2 below presents our estimation results for both parametric and semi-parametric survival models. As both sets of models lead to very similar results, we concentrate our subsequent discussion on the semi-parametric regression results. Furthermore, although our estimates for the three sub-sets of cities partly differ in terms of both size and significance levels of the coefficients, we consider the third sub-set as most suitable. Therefore, we limit our subsequent discussion to the results reported in column (3) in Table 2.

Table 2: Estimation results

	Semi-Parametric			*Parametric (Gompertz)*		
	(1) All cities	(2) All larger cities above 20k inhabit.	(3) All larger cities above 20k inhabit. w/o cities near large cities	(4) All cities	(5) All larger cities above 20k inhabit.	(6) All larger cities above 20k inhabit. w/o cities near large cities
ln_Population	**1.2286***** (0.0832)	**1.5419***** (0.1208)	**1.6836***** (0.1417)	**1.3022***** (0.1083)	**1.7743***** (0.1728)	**1.9787***** (0.2037)
Income	1.0339 (0.0295)	**1.0767***** (0.0286)	**1.0557*** (0.0341)	1.0417 (0.0379)	**1.0987**** (0.0402)	**1.0810*** (0.0475)
Under 24 years	**1.1335**** (0.0593)	**1.1887***** (0.0722)	**1.2130***** (0.0753)	**1.1855***** (0.0753)	**1.2349***** (0.0909)	**1.2676***** (0.1005)
Over 65 years	1.0249 (0.0322)	**1.1021**** (0.0447)	**1.1058**** (0.0503)	1.0376 (0.0379)	**1.1238**** (0.0542)	**1.1268**** (0.0620)
Higher education	**1.0146*** (0.0088)	**1.0197**** (0.0100)	1.0121 (0.0110)	**1.0170*** (0.0098)	**1.0231**** (0.0112)	1.0169 (0.0129)
Tourism	**1.0176***** (0.0062)	**1.0382***** (0.0084)	**1.0416***** (0.0090)	**1.0225***** (0.0073)	**1.0501***** (0.0098)	**1.0576***** (0.0106)
Motorway distance	1.0090 (0.0058)	1.0028 (0.0096)	1.0004 (0.0100)	**1.0115*** (0.0066)	1.0054 (0.0106)	1.0024 (0.0112)
Automobile density	**0.9786***** (0.0015)	**0.9806***** (0.0011)	**0.9830***** (0.0010)	**0.9777***** (0.0021)	**0.9797***** (0.0018)	**0.9817***** (0.0015)
IC rail access	1.1023 (0.1419)	1.1593 (0.1693)	1.0949 (0.1766)	1.0946 (0.1609)	1.1674 (0.2006)	1.0658 (0.2089)
Test of prop. hazard ass. $p>x^2$ for all cov	(✓)	✓	✓			
Av. time-to-failure				124.27	90.82	71.17
LR x^2	339.03	459.68	465.96	189.56	257.99	272.19
$p>x^2$	0.00	0.00	0.00	0.00	0.00	0.00
# subjects	2,054	643	342	2,054	643	342
# observations	44.747	12.203	5.453	44.747	12.203	5.453

Exponentiated coefficients; Standard errors in parentheses; * p < 0.1, ** p < 0.05, *** p < 0.01. Except for income in specification (1) the proportional hazard assumption is not rejected. Gompertz distribution provides best fit according to information criteria (AIC and BIC).

As shown in Table 2, we find that five demographic and one mode-related characteristic have significant influences on the probability that a city is connected to the interurban bus network. Although the mere size of a city's population has the (by far) largest effect, further *demographic characteristics* such as the average income or the share of young and old inhabitants – representing the two major target customer groups of interurban bus providers[1] – also increase the probability of network access significantly. Furthermore, an increasing importance of tourism has a further positive – yet rather small – impact on the probability to

[1] Interestingly, as indicated by the respective coefficients, the share of under 24 years old is twice as important for gaining access to the network than the share of over 65 years old.

gain network access.

Turning to the *mode-related characteristics*, we find that an increasing automobile density imposes a negative impact on the probability to gain interurban bus access. However, the average distance from the respective city to the next motorway – generating additional time-related costs for both providers and (transit) customers already on the bus – is found to have no statistically significant effect on the probability of network access. The same conclusion is true for the presence of a railway station with fast IC/ICE access – suggesting that interurban bus providers neither aim at providing a perfect complement nor a perfect substitute to the existing intercity rail network.

Finally, the application of the fully parametric model also allows us to predict the average survival time (or time-to-failure). In our case this corresponds to the time needed until all cities will be populated. In the most restrictive case (6) and fixing all covariates at their means, it will take about 6 years (71 months) until all cities in this category will be populated. This value increases to 7.5 years (90 months) and well above 10 years (124 months) in the less restrictive cases (5) and (4).

4 Conclusion

Bringing a country's citizens closer together is the key function of public passenger transportation services provided by airplanes, trains, ferries or buses. In this context, we have investigated the characteristics of cities gaining access to the German interurban bus network in the first two years following the deregulation of the industry in January 2013. Applying both parametric and semi-parametric survival models, we find strong evidence that the probability of a city to be added to a provider's network not only increases with the mere size of its population but also with further demographic characteristics such as average income or the share of young and old inhabitants. Additionally, while an increasing importance of tourism has a further positive effect, a rising automobile density is imposing a significantly negative impact on the probability of a city to gain access to the network.

From a policy perspective, we can conclude that, on the one hand, the deregulation of the interurban bus industry has clearly improved the mobility options of particularly citizens with lower incomes living in larger cities. It therefore appears likely that the deregulation of the industry creates substantial and clearly positive welfare effects – also by imposing increasing pressures on intermodal competitors such as particularly railway services. On the other hand, although the deregulation of the interurban bus industry has certainly also improved the accessibility of a significant amount of smaller cities without intercity rail access, our empirical results also suggests that a larger fraction of smaller cities do not have the necessary characteristics to make them an attractive addition to a provider's interurban bus network in the not too distant future.

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