EE²

DIW Berlin

German Institute for Economic Research

Efficiency Analysis of German Public Transit – Is Big Beautiful?

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Agenda

1. Issues, Motivation, Literature
2. Methods
3. Data and Model Specification
4. Empirical Results
5. Conclusions

ÖPNV - Verkehrsverbünde

1	Aachener Verkehrsverbund (AVV)	33	Verkehrsgemeinschaft Landkreis Cham (VLC)
2	Augsburger Tarif- und Verkehrsverbund (AVV)	34	Verkehrsgemeinschaft Landkreis Passau (VLP)
3	Bodensee-Oberschwaben Verkehrsverbund (BOI	35	Verkehrsgemeinschaft Münsterland (VGM)
4	Donau-Iller-Nahverkehrsverbund (DING)	36	Verkehrsgemeinschaft Niederrhein (VGN)
5	Gemeinschaftstarif Vorpommern (GTV)	37	Verkehrsgemeinschaft Rottal-Inn (VGRI)
6	Großraum-Verkehr Hannover (GVH)	38	Verkehrsgemeinschaft Ruhr-Lippe (VRL)
7	Hamburger Verkehrsverbund (HVV)	39	Verkehrsgemeinschaft Westfalen-Süd (VGWS)
8	Heidenheimer Tarifverbund (HTV)	40	Verkehrsunternehmensverbund Mainfranken (VVM)
9	Heilbronner-Hohenloher-Haller Nahverkehr (H3N	41	Verkehrsverbund Berlin-Brandenburg (VBB)
10	Karlsruher Verkehrsverbund (KVV)	42	Verkehrsverbund Bremen/Niedersachsen (VBN)
11	Kitzinger Nahverkehrs Gemeinschaft (KING)	43	Verkehrsverbund Großraum Nürnberg (VGN)
12	KreisVerkehr Schwäbisch-Hall (KVSH)	44	Verkehrsverbund Hegau-Bodensee (VHB)
13	Ludwigsluster Tarifverbund (LTV)	45	Verkehrsverbund Mittelsachsen (VMS)
14	Mitteldeutscher Verkehrsverbund (MDV)	46	Verkehrsverbund Neckar-Alb-Donau (NALDO)
15	Münchner Verkehrs- und Tarifverbund (MVV)	47	Verkehrsverbund Oberelbe (VVO)
16	Nordhessischer Verkehrsverbund (NVV)	48	Verkehrsverbund Ostwestfalen-Lippe/Der Sechser (VVOWL)
17	Regensburger Verkehrsverbund (RVV)	49	Verkehrsverbund Pforzheim-Enzkreis (VPE)
18	Regio Verkehrsverbund Lörrach (RVL)	50	Verkehrsverbund Region Kiel (VRK)
19	Regio-Verkehrsverbund Freiburg (RVF)	51	Verkehrsverbund Region Trier (VRT)
20	Rhein-Main-Verkehrsverbund (RMV)	52	Verkehrsverbund Rhein-Mosel (VRM)
21	Rhein-Nahe-Nahverkehrsverbund (RNN)	53	Verkehrsverbund Rhein-Neckar (VRN)
22	Saarländischer Verkehrsverbund (saarVV)	54	Verkehrsverbund Rhein-Ruhr (VRR)
23	Schleswig-Holstein-Tarif (SH-Tarif)	55	Verkehrsverbund Rhein-Sieg (VRS)
24	Tarifgemeinschaft Lübeck (TGL)	56	Verkehrsverbund Rottweil (VVR)
25	Tarifverbund Ortenau (TGO)	57	Verkehrsverbund Schwarzwald-Baar (VSB)
26	Tarifverbund Schaffhausen (TVSH)	58	Verkehrsverbund Süd-Niedersachsen (VSN)
27	Verbundtarif Mittelthüringen/Voll-Mobil-Ticket (VM	59	Verkehrsverbund Tuttlingen/TuTicket (VTU)
28	Verbundtarif Region Braunschweig (VRB)	60	Verkehrsverbund Vogtland (VTV)
29	Verkehrs- und Tarifverbund Stuttgart (VVS)	61	Verkehrsverbund Warnow (VVW)
30	Verkehrs-Gemeinschaft Freudenstadt (VGF)	62	Waldshuter Tarifverbund (WTV)
31	Verkehrsgemeinschaft am Bayerischen Untermai	63	Westpfalz Verkehrsverbund (WVV)
32	Verkehrsgemeinschaft Bäderkreis Calw (VGC)	64	Zweckverband Verkehrsverbund Oberlausitz-Niederschlesien (ZVON

Quelle: http://www.oepnv-info.de/dkarte/index.php

Motivation: (German) Public Transit in Turmoil

„Wir wollen Wettbewerb, und wir haben bereits einen funktionierenden Wettbewerb im deutschen ÖPNV. Was wir aber nicht wollen, sind unfaire Konkurrenzbedingungen zwischen einem kleinen Busunternehmer und einem europäischen Mobilitätsgroßkonzern. Das hätte nicht unseren Vorstellungen eines fairen Wettbewerbs entsprochen, der in Deutschland die Existenz von *mehr als 1000 gut aufgestellten mittelständischen Unternehmen* gefährdet hätte.“

Bundesverkehrsminister Tiefensee: Pressemitteilung zum EU-Verkehrsministerrat mit dem Thema ÖPNV-Verordnung 1191 (Bonn, 9. Juni 2006) (Hervorhebung zugefügt)

=> „We want competition, … but not if it endangers our 1,000 small and medium enterprises“

Minister of Transport Wolfgang Tiefensee

State of the Literature (I): No Clear Evidence

Berechman (1993): „Results concerning economies of scale are rather inconclusive“:

- Bus industry as a whole: constant scale economies
- Small firms (less than 100 buses) likely to experience increasing scale efficiencies
- Medium-sized firms (100-500 buses) facing very small or constant scale economies
- Large-scale bus systems (> 500 buses) most likely decreasing returns to scale (in particular Chicago: 2,500 buses, New York MTA: 3,000 buses)

Related literature on public transit efficiency measurement

- Farsi/Fillipini/Kuenzle (2005, 2006): on stochastic frontiers and average cost functions, indicating first falling, then rather constant average costs

State of the Literature (II): No Clear Evidence

Brons et al. (2005) → overview of different aspects and applications; explain the variation in efficiency findings reported in the literature

Viton (1981) → specify and estimate flexible cost functions for 54 US bus transit companies; advantages of translog cost functions

<u>Several country studies except for Germany</u>

Mizutani and Urakami (2002) → efficiency between private and public bus operators in Japan; apply econometric cost functions

Matas and Raymond (1998) → Spain during the period 1983–1995; econometric cost function

Filippini and Prioni (1994), Filippini and Prioni (2003) → Swiss regional bus companies; cost frontier approach; question if inefficiencies are due to a regulatory problem.

Tulkens (1993) → apply the methodology of free disposal hull (FDH) to measure of productive efficiency in urban transit.

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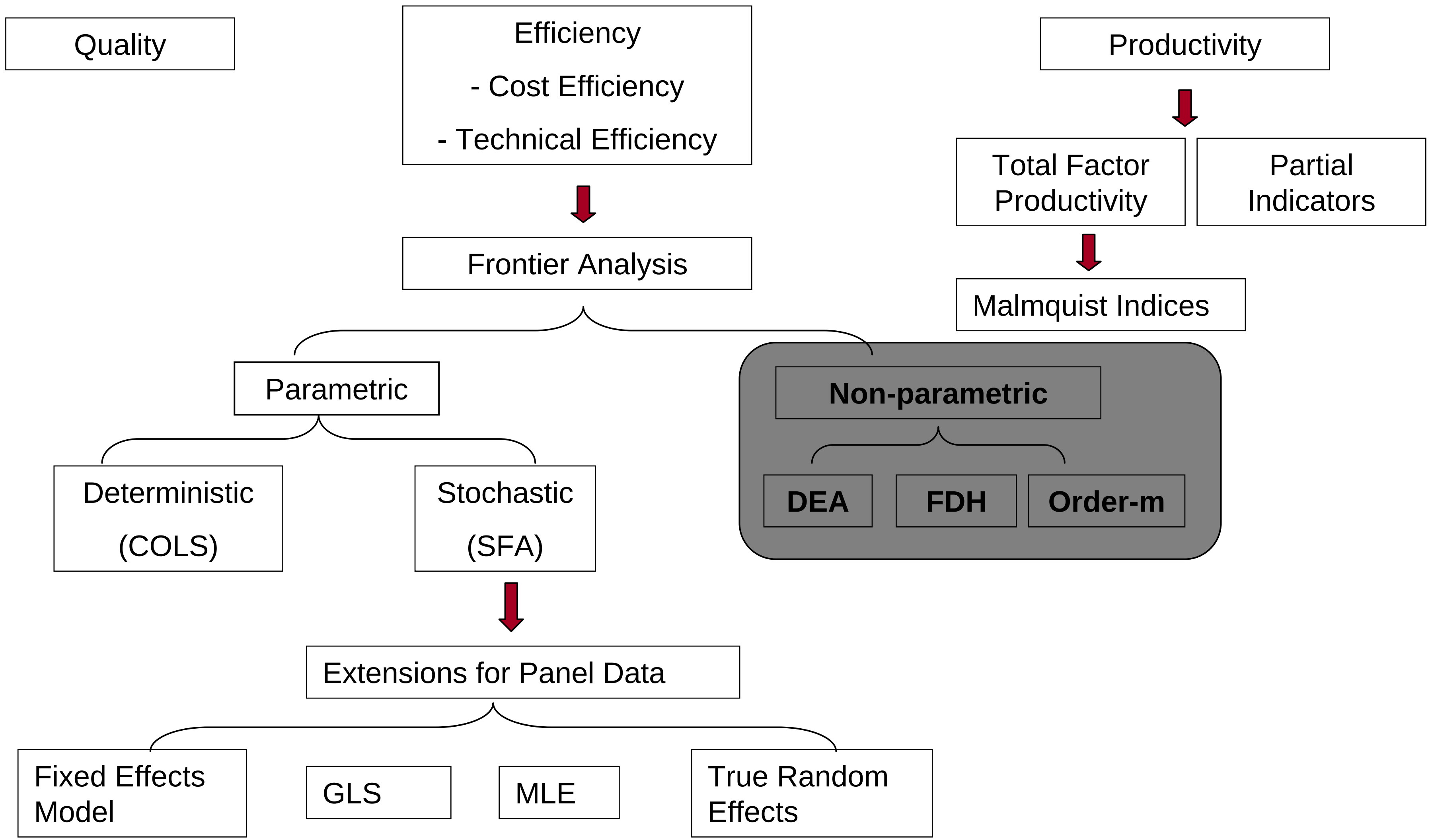
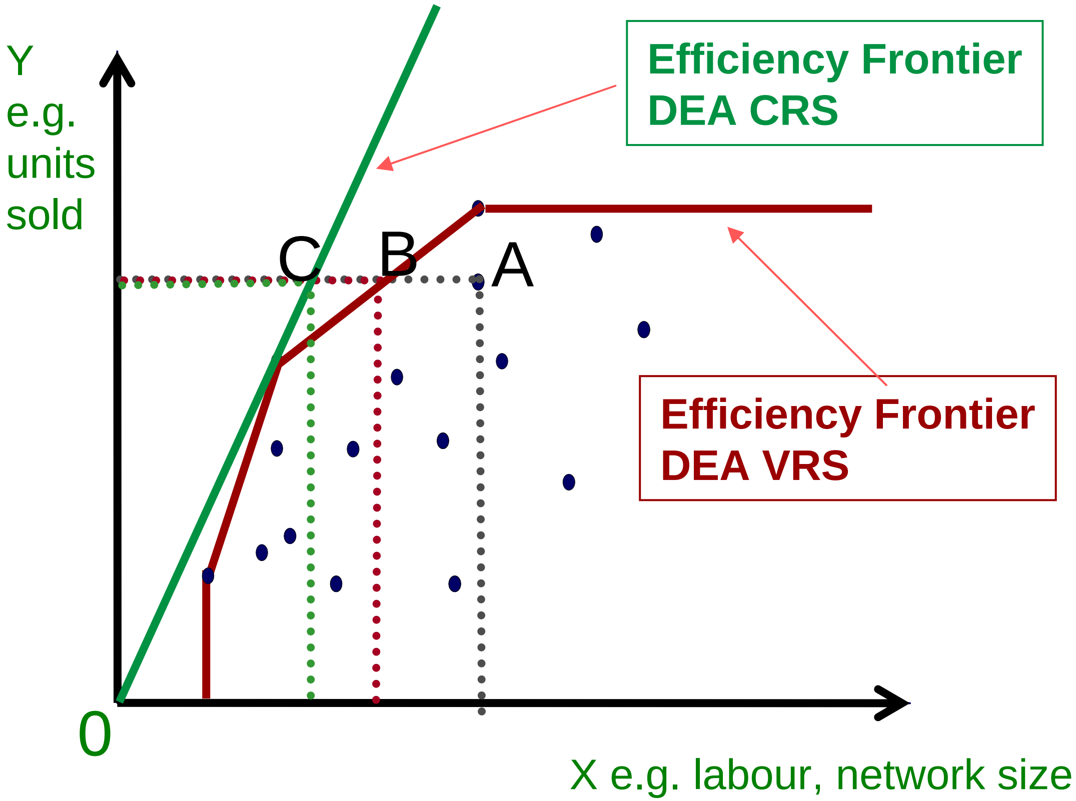
Benchmarking Methods – Survey



Data Envelopment Analysis (DEA)



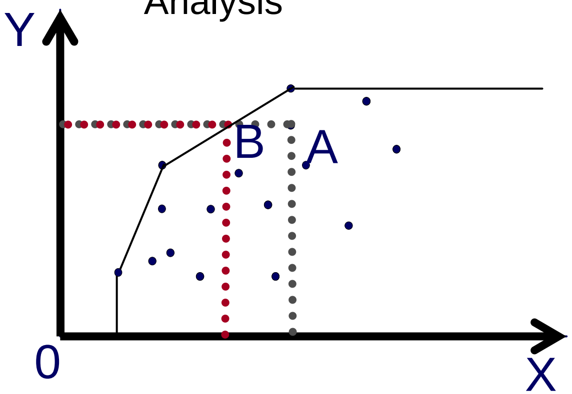
$$
\begin{aligned}
&\max_{u,v}(u\'y_i / v\'x_i),\\
&u\'y_i / v\'x_i \leq 1,\ j = 1, 2, \ldots N\\
&u, v \geq 0
\end{aligned}
$$

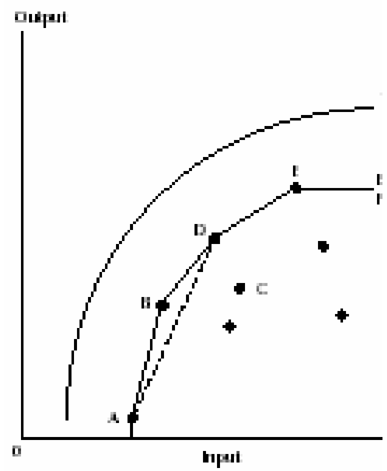
$$
\begin{aligned}
&\max_{\mu,v}(\mu\', y_i),\\
&v\'x_i = 1\\
&\mu\'y_i - v\'x_i \leq 0,\ j = 1, 2 \ldots, N\\
&\mu, v \geq 0,
\end{aligned}
$$

$$
\begin{aligned}
&\min_{\theta,\lambda} \theta,\\
&-y_i + Y\lambda \geq 0\\
&\theta x_i - X\lambda \geq 0\\
&\lambda \geq 0
\end{aligned}
$$

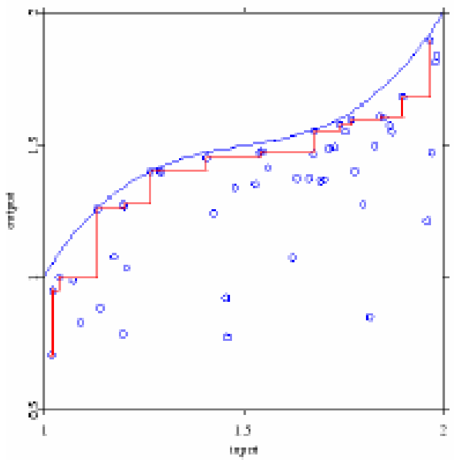
Methods

Data Envelopment Analysis

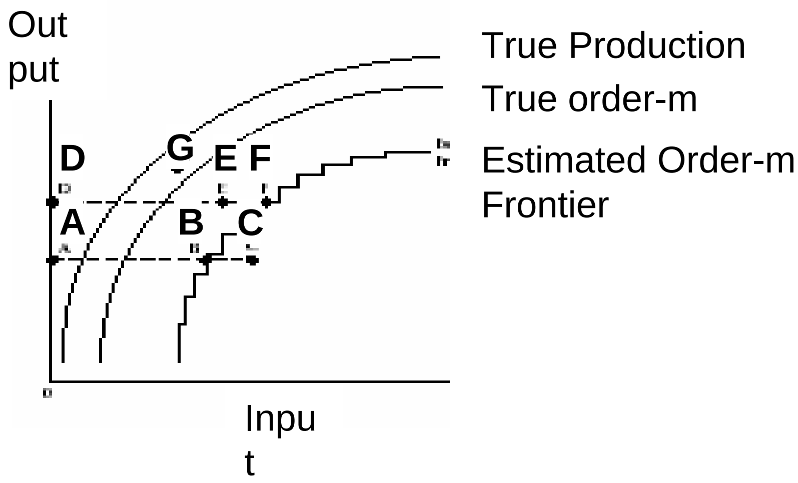




Free Disposal Hull



Order-m



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Model Specification (I)

Empirical analysis of the technical efficiency:

Look in detail at 200 German public transit bus companies (including companies operating exclusively in the public bus transit, not included companies operating in different transit sectors (multi-output including metro))

- → **Observation period (1990-2004)**
- → **Different nonparametric approaches (DEA, FDH, Order-m)**
- → **Sensitivity Analysis by means of Bootstrapping**

Model Specification (II) – Data Description

- **Physical and geographical data**
- **Technical efficiency only (no cost and input factor price data available at this time)**
- **Cannot consider allocative efficiency**
- **Data taken from VDV "Verband deutscher Verkehrsunternehemen"**

- **Sorted out missing data – balanced panel**
- **Problem of outsourcing: sorted out utilities with less than 10 employees**
- **Companies including all sizes operating in urban and rural service areas**

Model Specification (III) – Base Model

Production Frontier Models

Inputs:

Labour: number of workers

Number of busses approximation for capital input

Outputs:

Seat kilometers

Model Variation (Sample 1990-2004)

	Input Labor	Input Busses	Input Length of Lines in km	Input Density Index	Output Seat km	Output Bus km	Output Passengers km
Model 1	I	I			I		
Model 2	I	I				I	
Model 3	I	I					I
Model 4	I	I		I			I
Model 5	I	I		I (non-dis)			I

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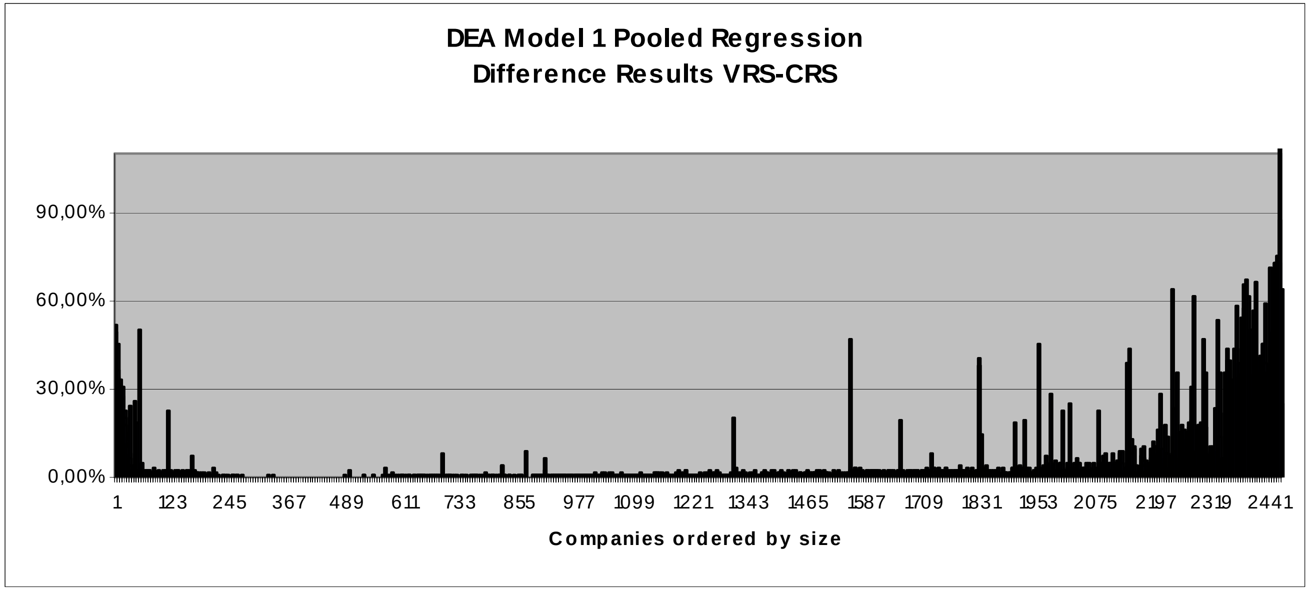
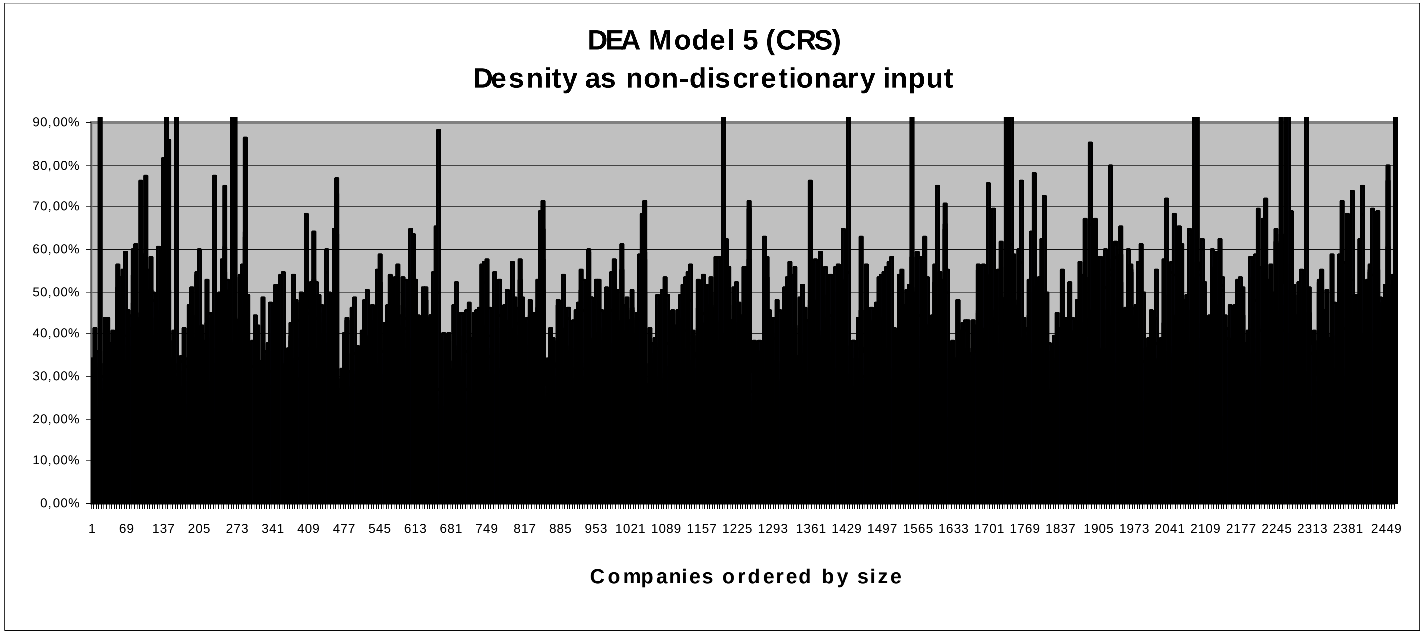
DEA Model 1 Pooled Regression



Difference increases when firm size decreases,
→ scale inefficiency (IRS)

DEA Model 5 (CRS) Including Density



Small utilities operating in less densely settled areas are

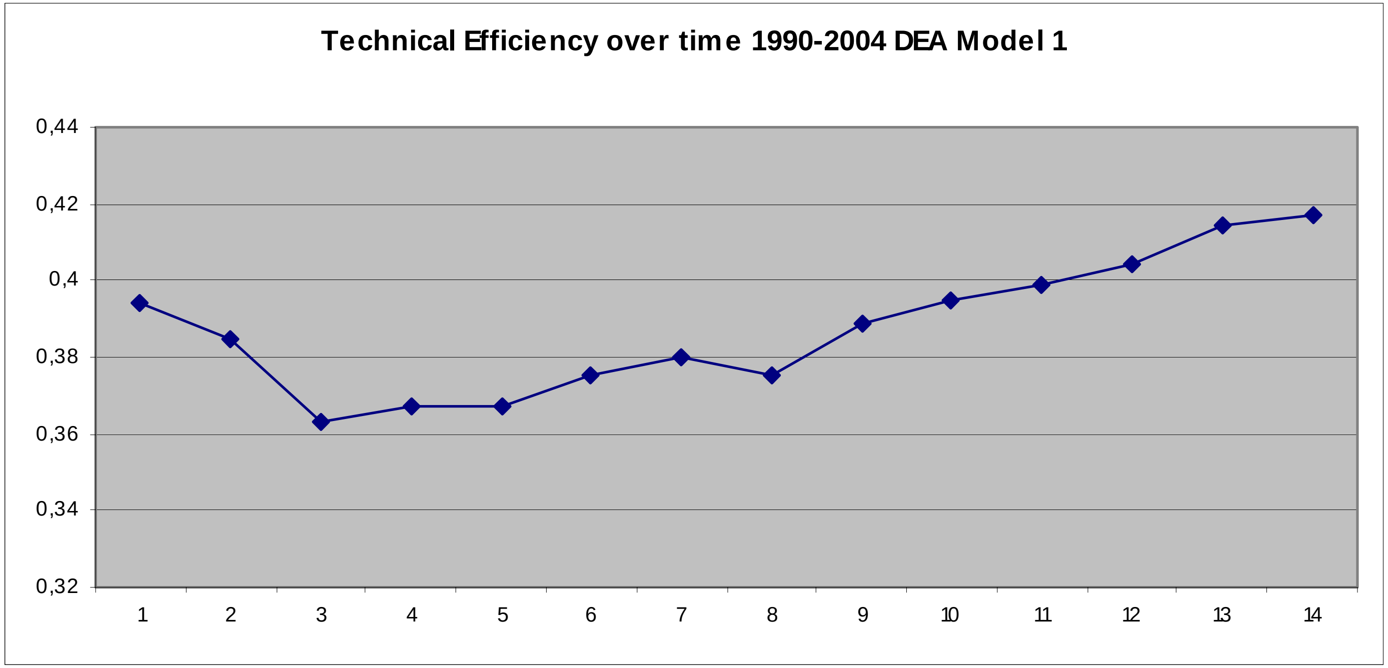
Most Efficient Companies

2003	Künzelsau (NVH)	1,25	1,33	1,00
2004	Ulm (RAB)	1,13	1,39	1,00
2002	Burg(NJL)	1,08	1,08	1,00
1998	Burg (NJL)	1,00	1,03	1,00
1999	Burg(NJL)	1,00	1,01	1,00
1991	Celle (OHE)	0,96	0,97	1,00
1991	Bad Pyrmont	0,95	1,03	1,00
1999	Weimar (Verwaltungsges)	0,93	1,02	1,00
1990	Ulm (RAB)	0,93	1,17	1,00
2003	Burg(NJL)	0,92	0,92	1,00
1990	Bad Pyrmont	0,91	0,99	1,00
2002	Weimar (Verwaltungsgesells	0,91	0,95	1,00
2003	Weimar (VWG des ÖPNV) '	0,91	0,95	1,00
2003	Ulm (RAB)	0,86	0,86	0,86
1990	Stuttgart (RBS)	0,85	0,98	1,00
2001	Groß-Gerau (RWGG)	0,85	0,88	1,00
1990	Bielefeld (BVO)	0,80	1,03	1,00
2004	Frankfurt/ Main (VU)	0,80	0,80	1,00
1990	Kassel (RKH)	0,79	0,98	1,00
1999	Lübeck (SL)	0,78	0,78	1,00

Including Super-efficiency

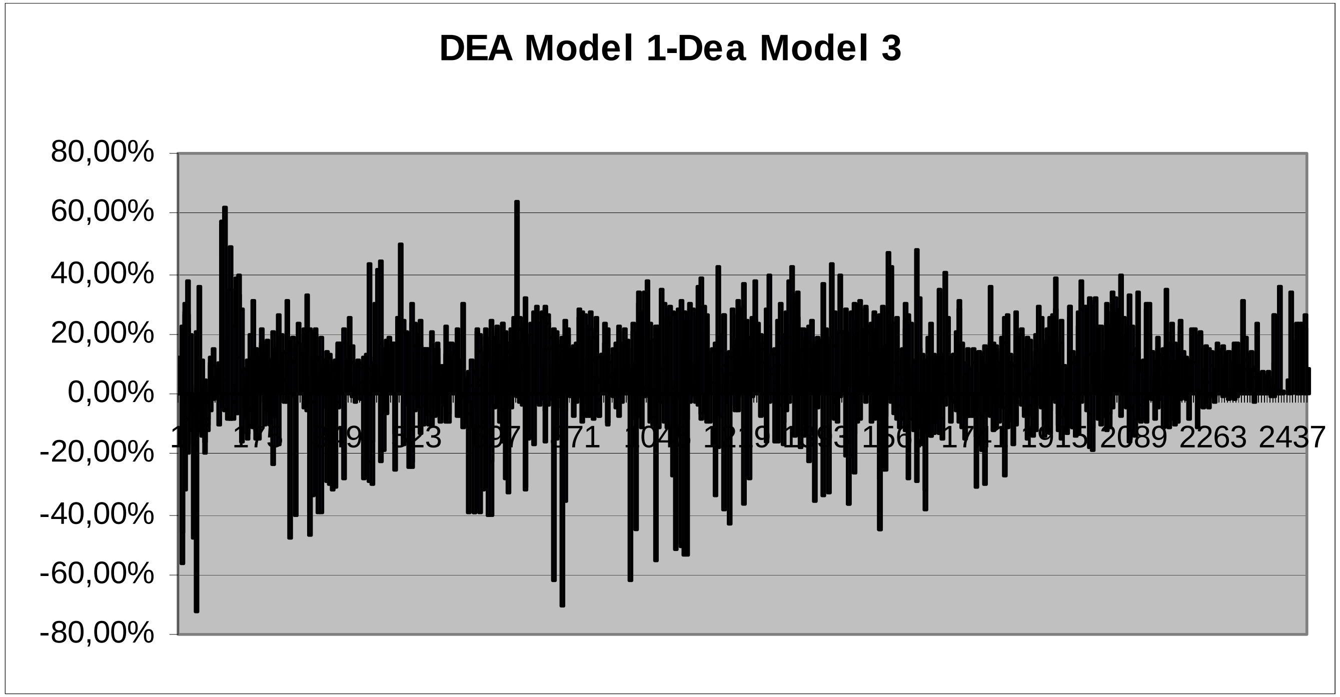
Problem of outsourcing, Künzelsau

Technical Efficiency over time 1990-2004 DEA Model 1



- **Technical Efficiency in the bus sector increases through the observation period (1990-2004) under the CRS assumption**
- **1995 = 0,39**
- **2004 = 0,42**
- **Results can be confirmed by the VRS and FDH assumption**

Comparison – Seat Utilization



- **Technical Efficiency in the bus sector higher when we define seat km as output**
- **→ inefficient use of seats (Auslastungsgrad!!)**

Test of Robustness

- **Correlation analysis (deterministic nonparametric DEA and stochastic Order-m estimation)**

0,78

- **FDH also confirms efficiency ranking of the most efficiency bus companies**

- **Bootstrapping: Mean Bias 0,19, Mean Variance 0,013.**

Conclusions

- Contrary to the international literature, German public transit seems characterized by increasing scale economies

- Uncertainty about the large enterprises

- Scale efficiency does not seem to have changed much recently

- This would imply high pressure on mergers and acquisitions (in fact, this is what one observes in reality)

- Extension with cost function necessary; more research necessary on allocative issues and cost functions

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