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Benchmarking Airports:

- 1- Overview of Master Thesis**
- 2- Proposals for Ph.D. Thesis**

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**1- Master Thesis:
Efficiency of German Airports
and Influencing Factors**



Introduction



Why Airport Benchmarking?

-Liberalization of Aviation Industry → More Competition

- Airport Management
→ More efficient operation
- Regulators
→ Selection of best regulation type
- Airlines and Passengers

Best-Practice-Airport

Introduction



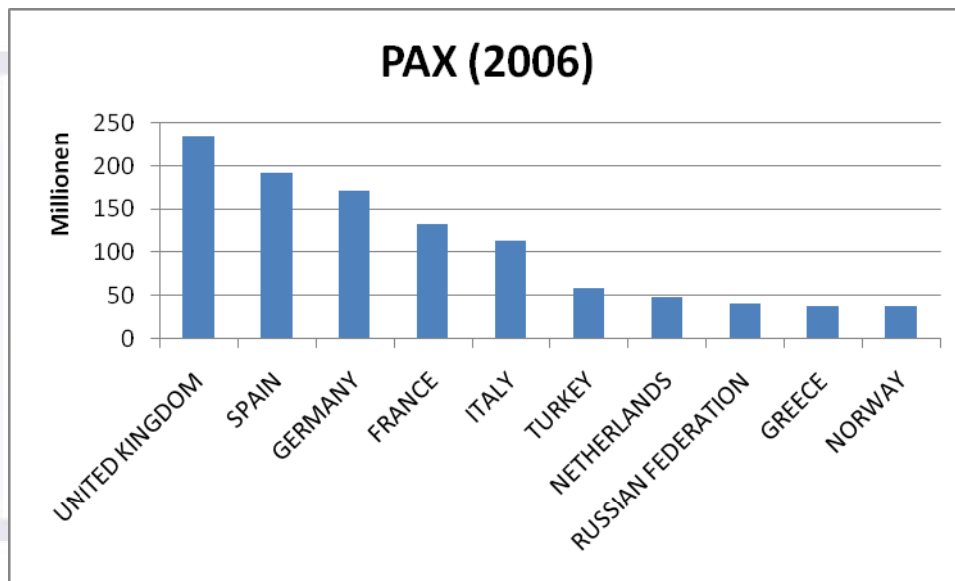
Why German Airports?

- 1- Third largest market in Europe
- 2- 30% traffic growth in 10 years
- 3- Future demand
- 4- Lack of Research
- 5- Poor performance in ongoing Research

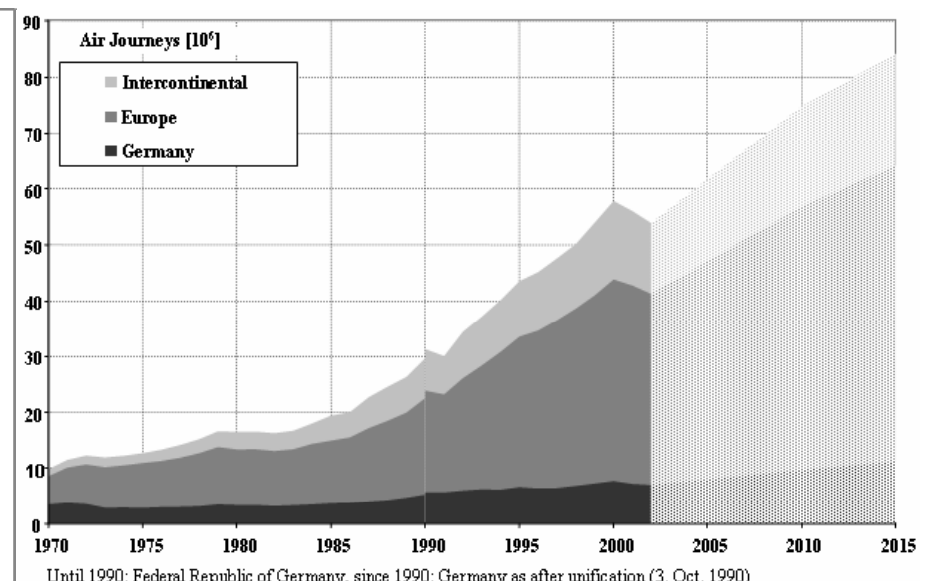


FIGURE 1: NUMBER OF PASSENGERS IN EUROPA

FIGURE 2: FUTURE DEMAND IN GERMAN AIRPORTS



Source: ACI World Airport Traffic Report, 2006



Source: Urbatzka & Wilken, 2004

Literature Review



1. Data Envelopment Analysis (DEA)

- Gillen and Lall (2001)
- Pels et al. (2001, 2003)
- Parker (1999)
- Martin and Roman (2001)
- Sarkis (2000)
- Bazargan and Vasigh (2003)

For different input-output combinations
---Technical
---Financial
---Mixed
---Innovative

2. Malmquist DEA

- Gillen and Lall (2001)
- Kamp et al (2004)
- Murillo-Melchor (1999)
- Barros and Weber (2009)

3. Bootstrapped DEA

- Simar & Wilson (1998)
- Barros (2008c)
- Barros and Dieke (2008)
- Assaf (2009)

Economic Factors on Airport Efficiency

Level of Airport Charges

→ For the operational and investment costs

- In case it does not cover the costs;

1. Government subsidies
2. Cross-Subsidization : Aeronautical vs. Concessions

Charges Regulation

Rate of Return vs. Incentive (price-cap)

1. ***Productive*** : Cost Minimization
2. ***Allocative*** : Price Mechanism
3. ***Dynamic*** : Investment Incentives

Economic Factors on Airport Efficiency

Airport Competition

- Overlapping Catchment Area
- Hub Airports
- Cargo Traffic
- LCC

Airport Ownership and Privatization

Parker (1999)
Vasigh and Haririan (2003)
Holvad and Graham (2003)
Oum et al. (2006)

VS.

Vogel (2006)
Oum et al. (2008)
Müller et al (2009)

No effect of privatization

Private airports are better

Airport Sector in Germany



Privatization:

DUS – HAM – FRA – HAJ – SCN – HHN

Regulation:

RATE OF RETURN: TXL – MUC – STR – CGN

INCENTIVE REGULATION: HAM- FRA- HAJ- DUS

Capacity Expansion

RWY and Terminal

Empirical Analysis

3-Step-Analysis:

- Bootstrapped DEA : Bias-corrected efficiency scores
→ *for Cost Efficiency*
- Spearman Rank Correlation Test
→ *for the relationship btw. Costs and Revenues*
- Second Stage Truncated Regression and Bootstrapping
→ *for the Influencing Factors*

Empirical Analysis

- Shephard Type DEA

$x = (x_1, \dots, x_N) \rightarrow$ Input vector

$y = (y_1, \dots, y_N) \rightarrow$ Output vector

Production Technology:

$$L(y) = \{x: x \text{ can produce } y\}, \quad y \in R_+ \quad (1)$$

Shephard input distance function:

$$D(y, x) = \sup\{\lambda \in R_+ : (x / \lambda) \in L(y)\} \text{ w.r.t. } \lambda, \quad (2)$$

- Second Stage Truncated Regression

$$TE_j \approx a + Z_j \delta + E_j \quad j = 1, \dots, n,$$

Technical Efficiency Scores from DEA

Vector of Independent Variables

Normally distributed error term with zero mean, sigma std. dev.

Data

Technology is determined by using:

Country	Airports	Years
Austria	1	98-05
Belgium	1	98-04
Denmark	1	98-05
France	1	98-99
Germany	13	unbalanced
Italy	22	2000-2005
Netherlands	1	98-05
Norway	1	2000-2005
Switzerland	1	98-07
UK	17	98-06
Total	59	

German Airports in the Analysis:

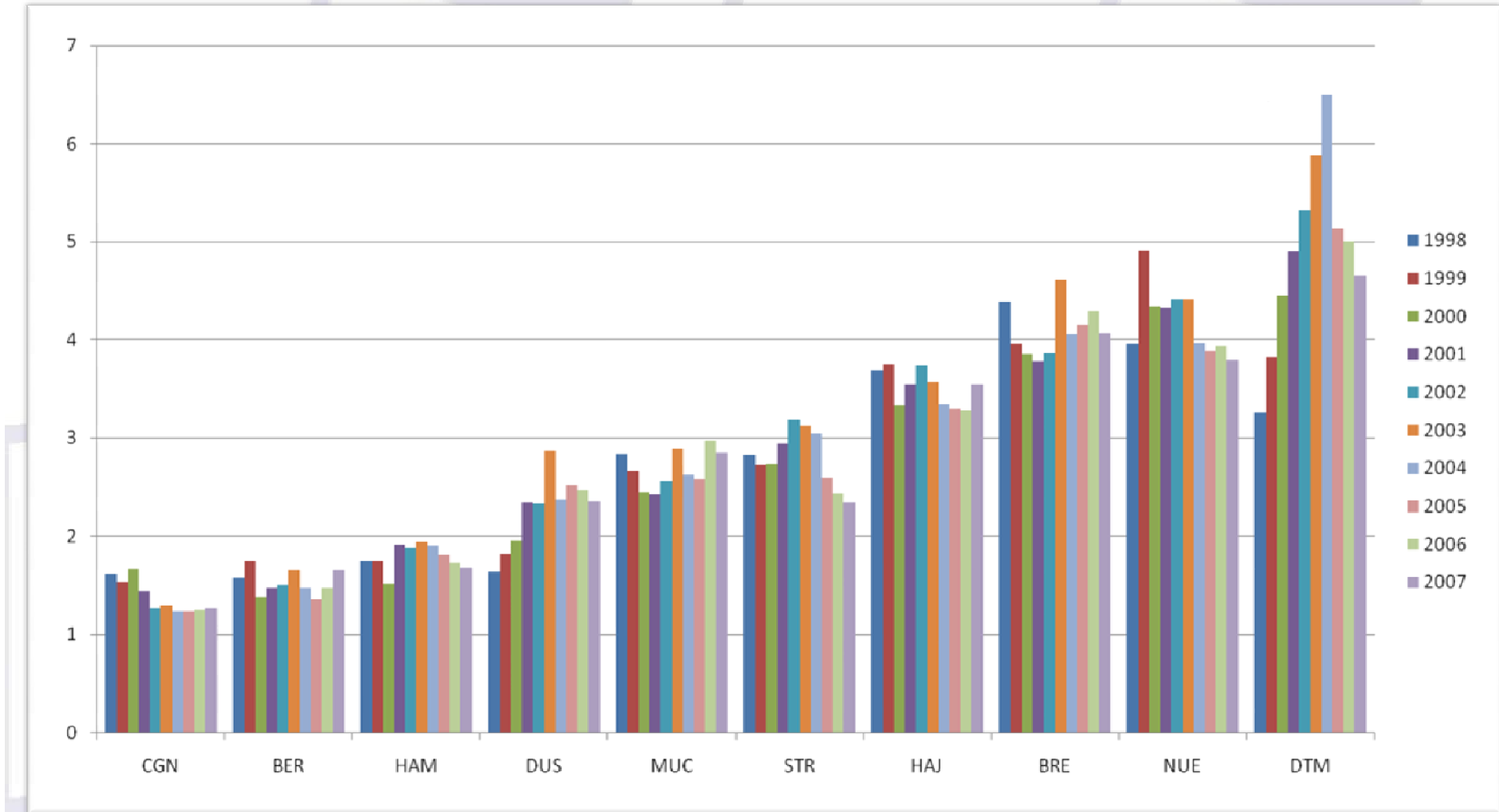
BER	CGN	DUS	HAM	NUE
BRE	DTM	HAJ	MUC	STR

Between 1998 und 2007

INPUTS	OUTPUTS
Staff Costs	PAX
Other Operating Costs	Cargo
Tangible Assets + Inventories	

Results

1 – DEA EFFICIENCY SCORES:



1,000 → FULLY EFFICIENT LEVEL

Results

2- SPEARMEN RANK CORRELATION TEST:

“DEA Efficiency Ranking” vs. “Revenues / Costs Ranking”

FORMULA:

$$r = 1 - \frac{6 \sum D^2}{n(n^2 - 1)}$$

$r = 0,762 > \text{Critical Value} = 0,43$

→ A monotonic correlation between Cost efficiency and revenue efficiency

Results



3- SECOND STAGE TRUNCATED REGRESSION AND BOOTSTRAPPING:

Influencing Factors

- **WLU – Airport Size**
- **Private Share**
- **Dummy variable for Regulation Type**
- **Staff Costs**
- **PAX/ATM – Average Aircraft Size**
- **Percentage of International Passengers**

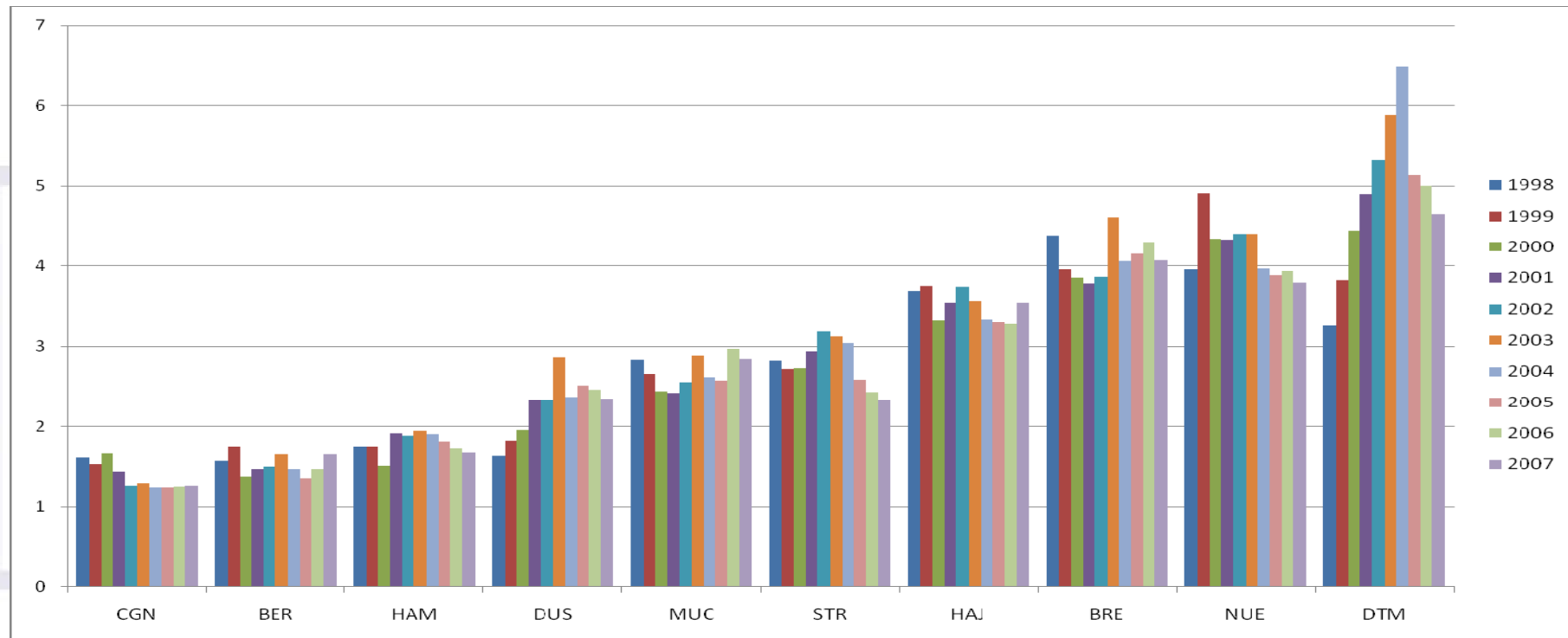
	Constant	WLU(airport size)	Private Share	Regulation Dummy	Staff Costs	PAX/ATM (Aircraft Size)	Int'l PAX Percentage
Coefficient	2,6553	-0,3113	-0,5399	-0,3816	0,0341	-0,0381	5,3755
Significant 1%	*	*			*	*	*
Significant 5%	*	*			*	*	*
Significant 10%	*	*		*	*	*	*

Discussion



Cologne-Bonn:

- LCC makes up 70% of total traffic
With lower cost → Maximum number of passengers
- High level of cargo traffic (hub for UPS, FEDEX)

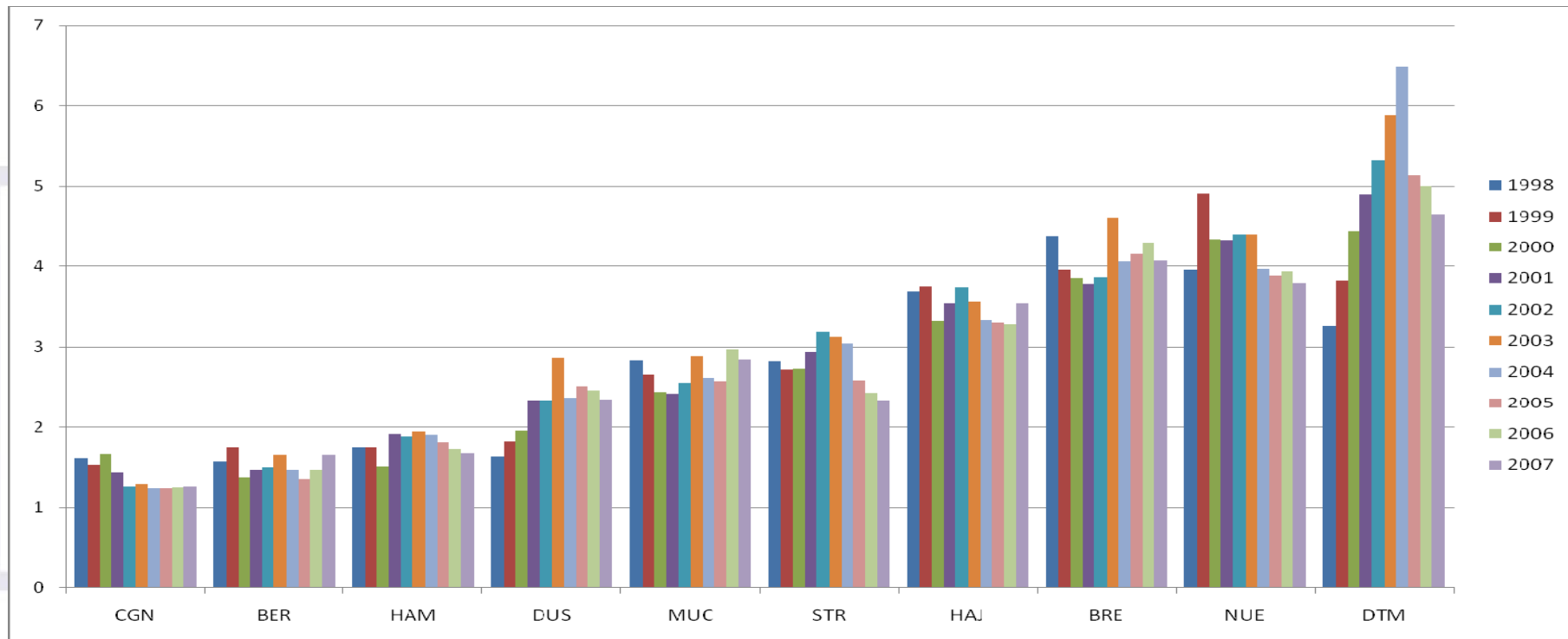


Discussion



Berlin Airports:

- 3rd busiest airport in Germany (High LCC share)
- TXL and SXF subsidize the high losses of THF
- Outsourcing GHS might give a cost advantage
- In fact lower revenues than average, both in aviation and non-aviation
- Distortion is possible due to consolidated data



Discussion



FIGURE 3: AERONAUTICAL REVENUES / ATM

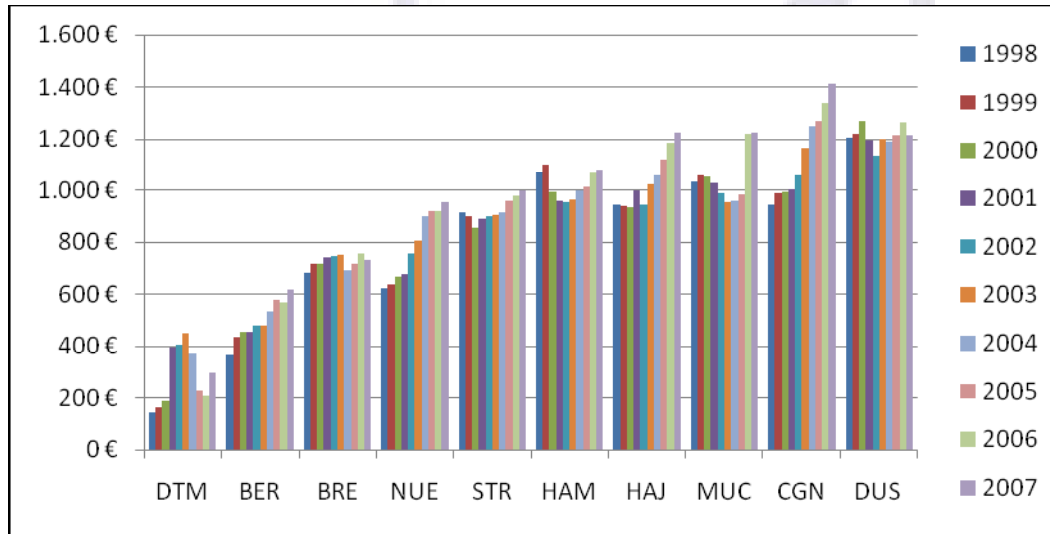
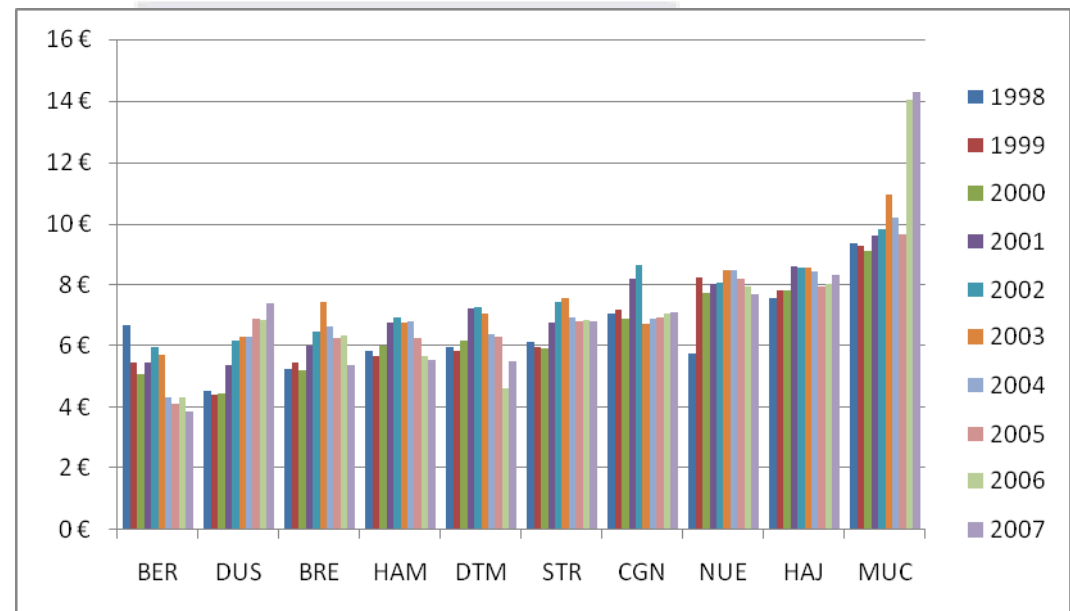


FIGURE 4: NON-AERONAUTICAL REVENUES / PAX

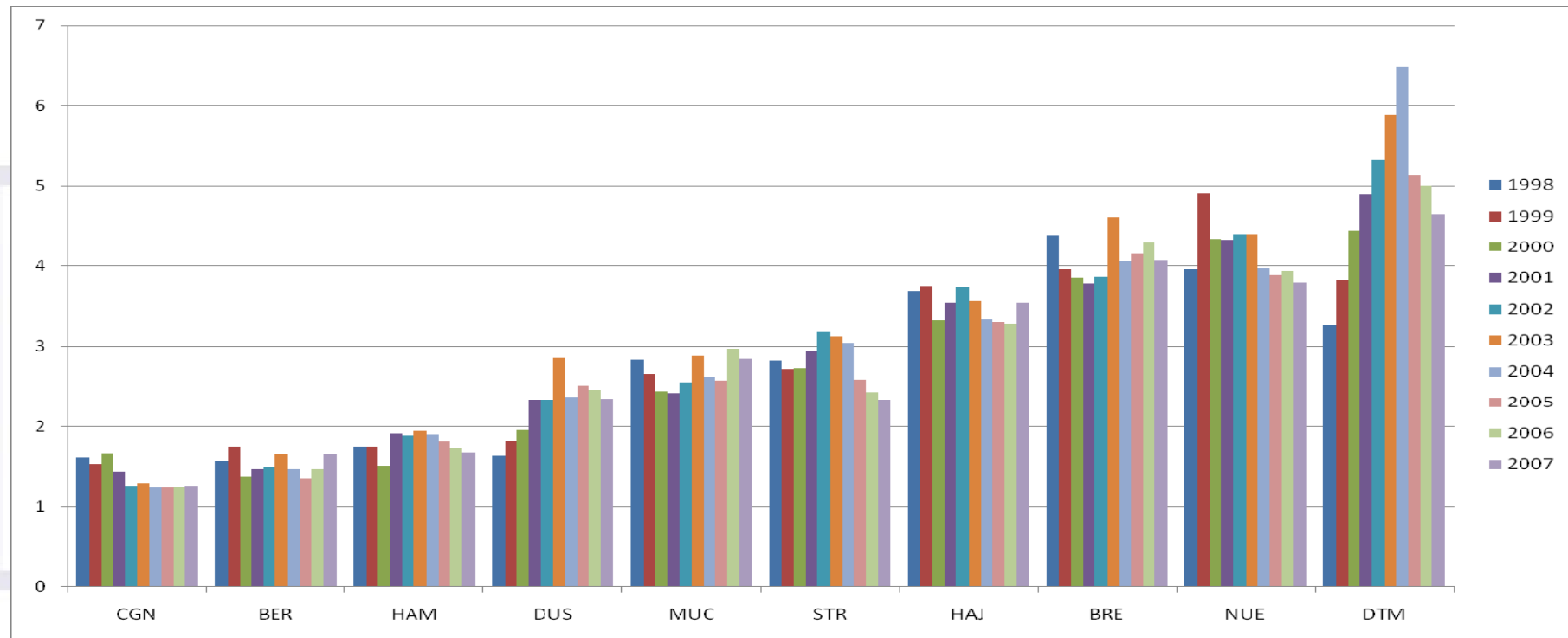


Discussion



Hamburg:

- Traffic focus on main carriers
- Competitive advantage, being in the north Germany
- Privatization & Incentive Regulation -- Good management
- Positive effects take place with a lag, starting in 2003

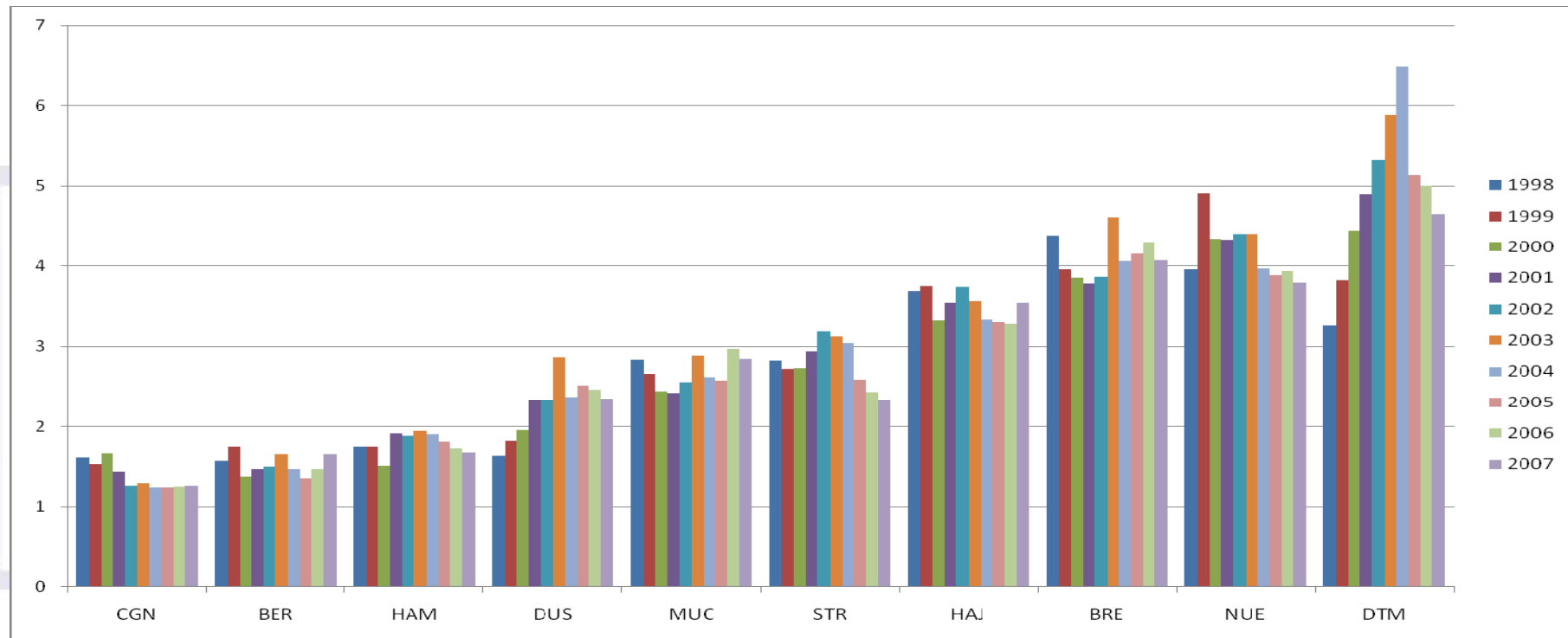


Discussion



Düsseldorf:

- Sharp deterioration until 2003
→ Because of capacity problems: Increase in traffic is limited
- Positive trend from 2005 on can be explained by:
 1. Incentive regulation
 2. Capacity expansion pays off

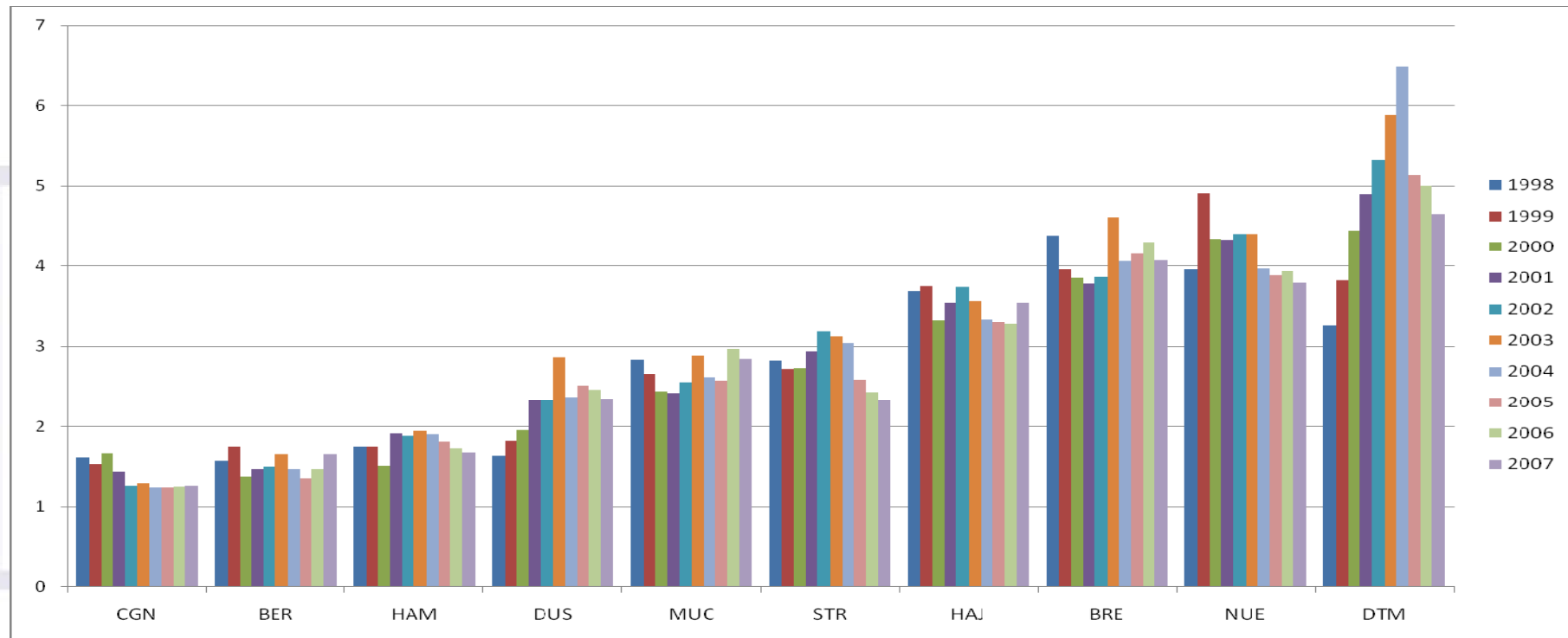


Discussion



Munich:

- High increase in PAX (120% in 10 years) → But, no positive effects
→ High increase in Costs (more than 100% in 10 years)
- High revenues from both aviation and non-aviation (figures 3 and 4)
- Needs strategies for cost minimizing

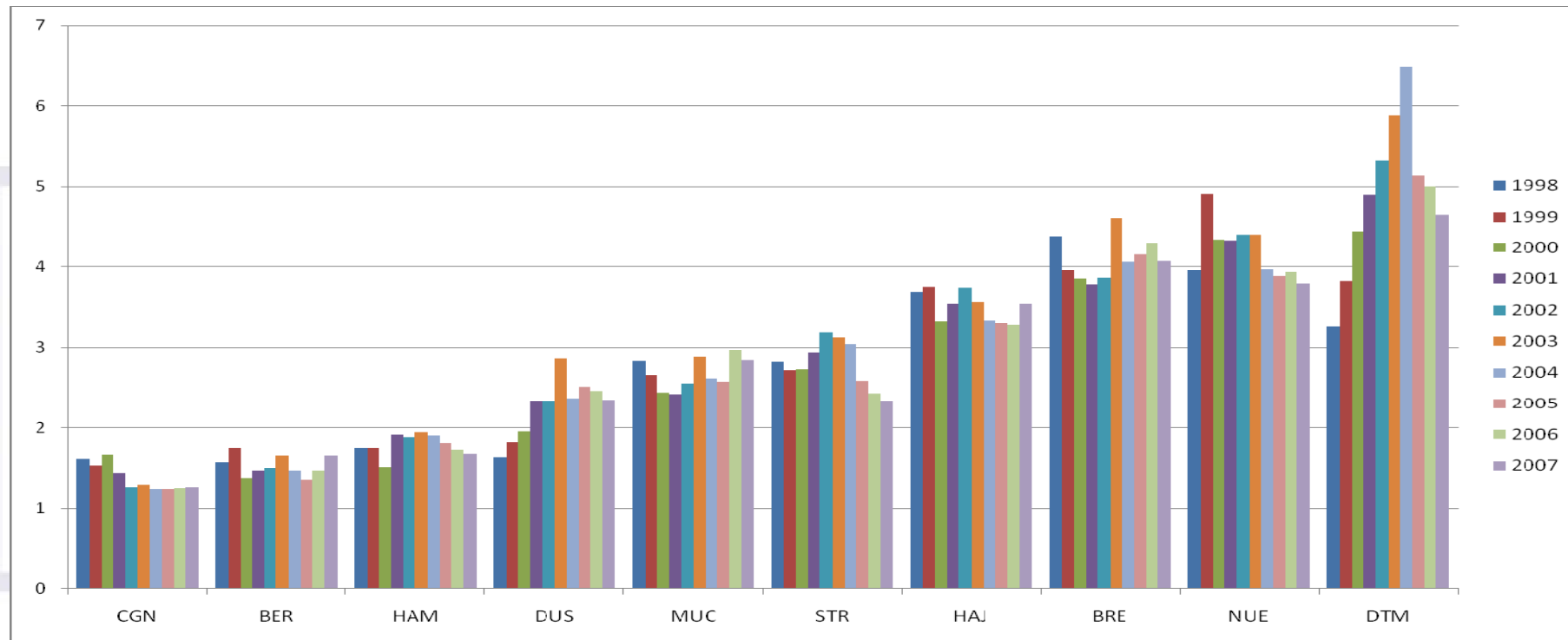


Discussion



Stuttgart:

- Increasing level of LCC traffic (Germanwings and TUIfly)
- Germanwings and TUIfly use STR as their base from 2003 on
- Costs stayed stable

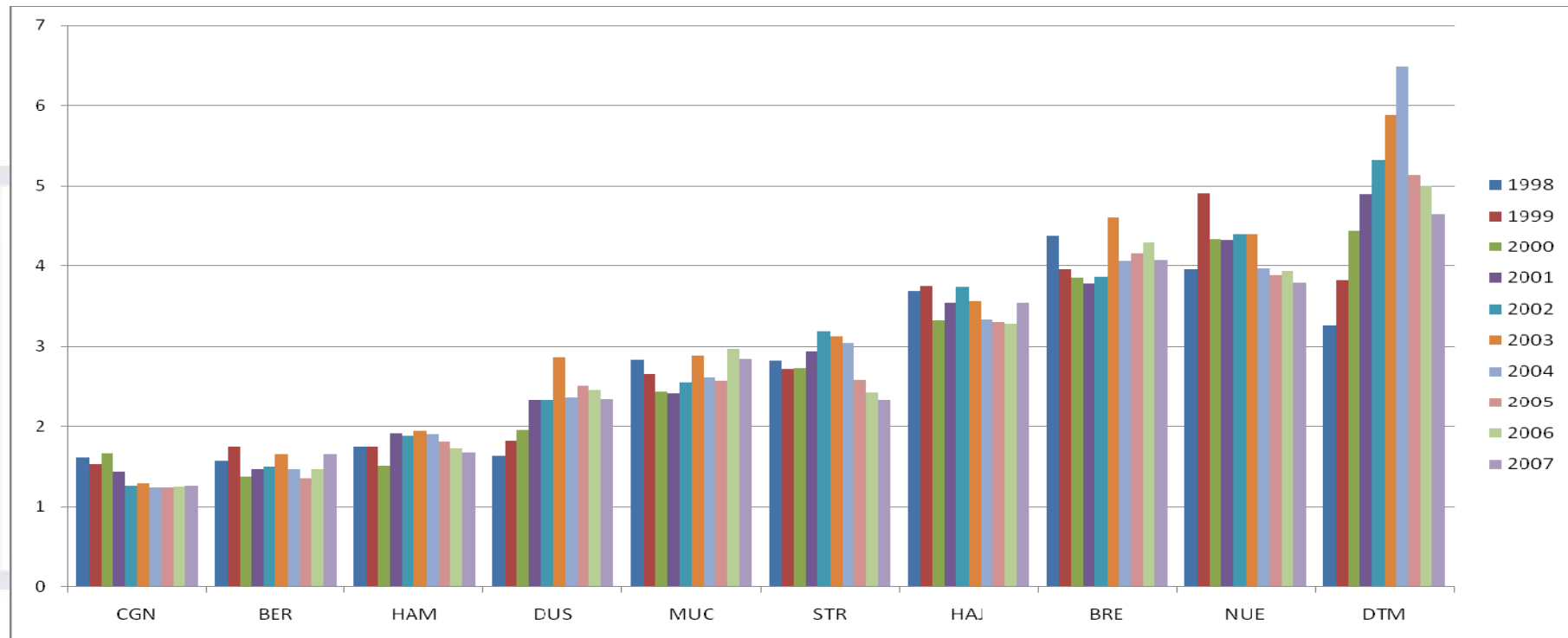


Discussion



Hanover:

- Old military airport with excess capacity
→ Inefficient use of resources
- High level of charges – Demand from LCC is low

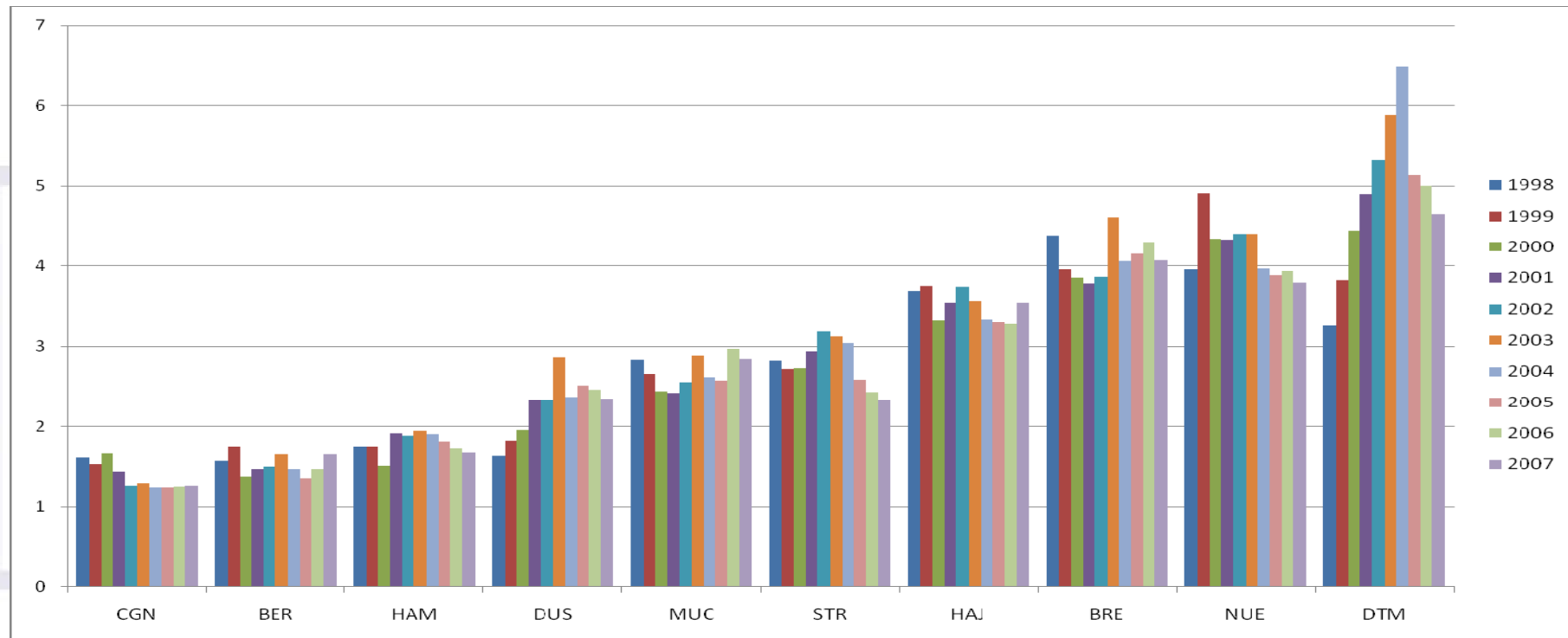


Discussion



Bremen:

- Secondary Airport in northern Germany
- Hamburg is a strong competitor
- Influencing factors are ambiguous

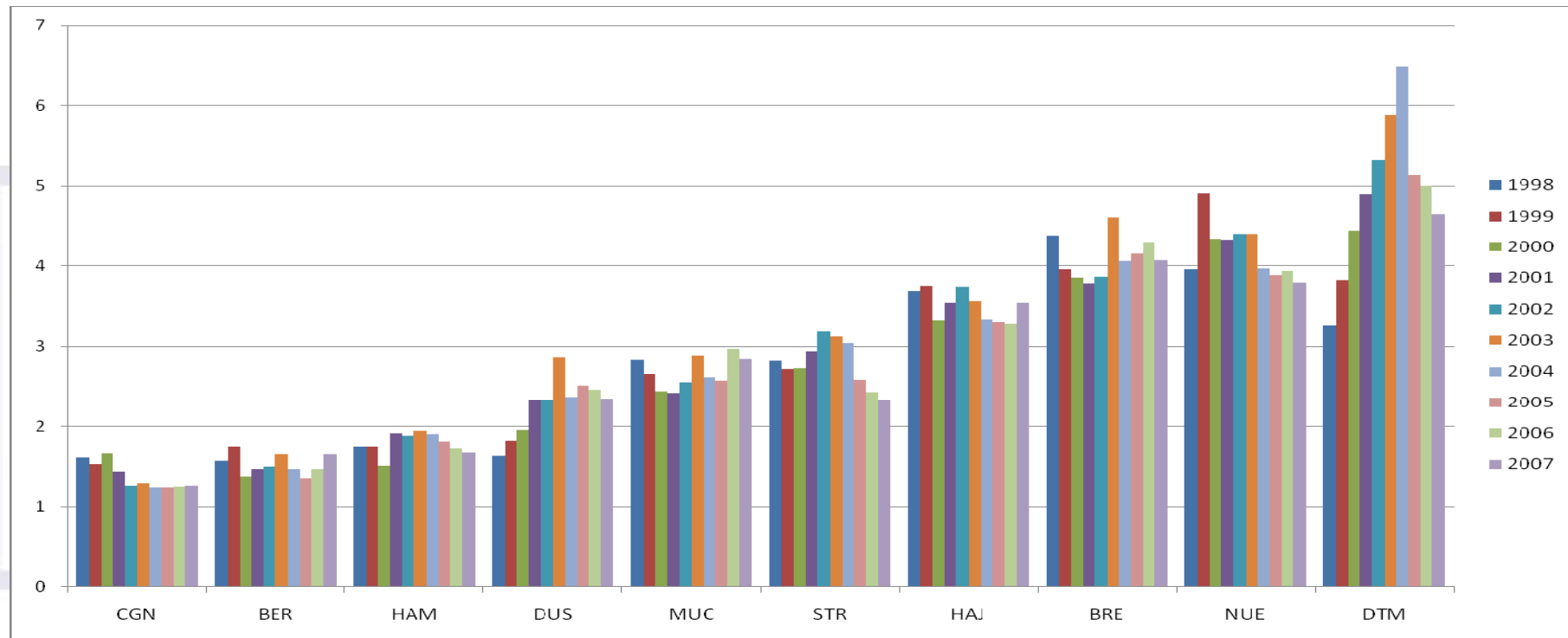


Discussion



Nuremberg:

- Very high staff and operating costs
→ Socio-economic characteristic of Bavaria (as in case of Munich)
- AirBerlin chose NUE as second hub
→ Positive trend after 2004

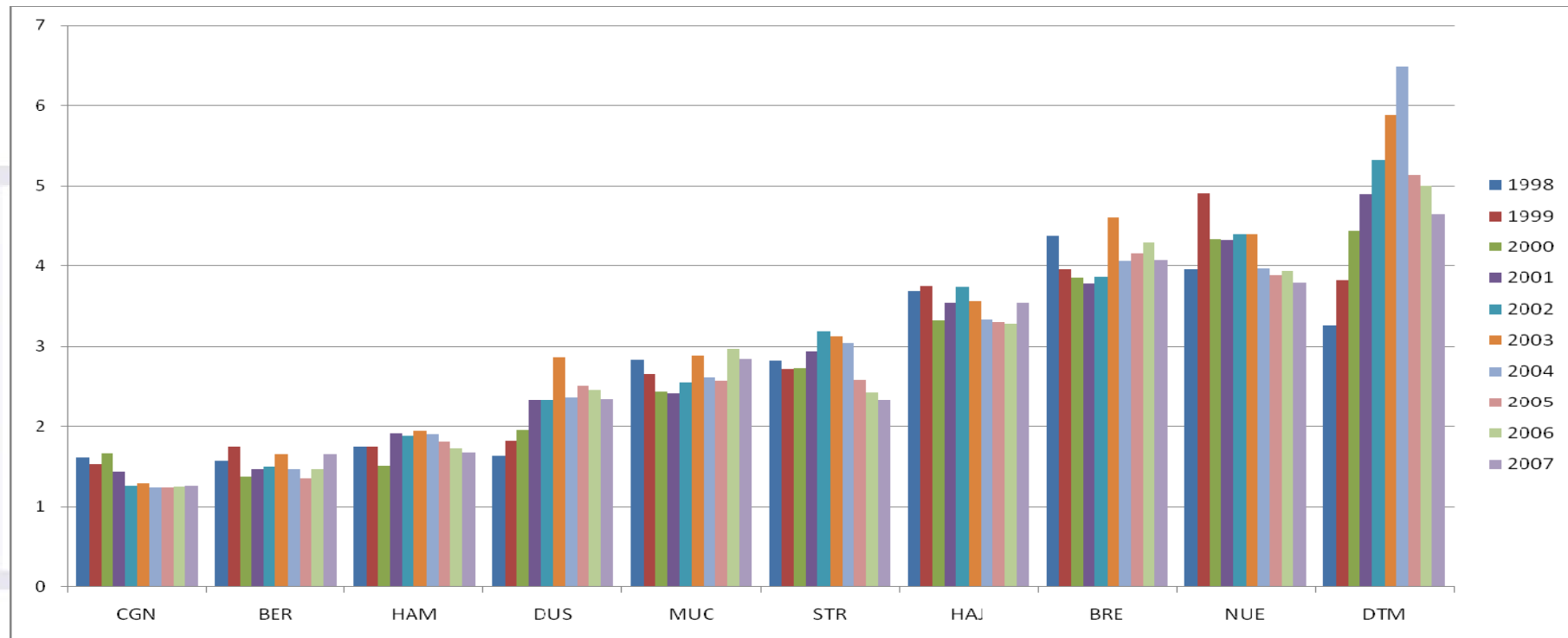


Discussion



Dortmund:

- Strong competition from DUS, CGN, FMO, PAD
- Small increase in traffic despite high capacity investments
- No incentive for more profits
→ Government subsidized all losses



Discussion



WLU (-0,3113): Larger airports are more efficient

- Confirms findings of Morrison (1983), Graham (2005), Oum et al (2003), Barros (2008)

Private Share (-0,5399): Privatization increases efficiency

- Hamburg and Düsseldorf, only with a lag
- Not significant

Regulation (-0,3816): Incentive Regulation contributes

- Privatized airports use incentive regulation, similar results

	Constant	WLU(airport size)	Private Share	Regulation Dummy	Staff Costs	PAX/ATM (Aircraft Size)	Int'l PAX Percentage
Coefficient	2,6553	-0,3113	-0,5399	-0,3816	0,0341	-0,0381	5,3755
Significant 1%	*	*			*	*	*
Significant 5%	*	*			*	*	*
Significant 10%	*	*		*	*	*	*

Discussion



Staff Costs (0,0341): Labor plays a significant role

Average Aircraft Size (-0,0381): The larger the aircraft the more efficient the airport is

- Not only by more revenue but also by lower average costs

% of Int'l Traffic (5,3755): More international, less efficient

- Contradicting the traditional view
- Graham(2005) states: int'l traffic requires higher costs and higher revenue → Cost efficiency is more sensitive
- DTM airport has a very high share of int'l traffic

	Constant	WLU(airport size)	Private Share	Regulation Dummy	Staff Costs	PAX/ATM (Aircraft Size)	Int'l PAX Percentage
Coefficient	2,6553	-0,3113	-0,5399	-0,3816	0,0341	-0,0381	5,3755
Significant 1%	*	*			*	*	*
Significant 5%	*	*			*	*	*
Significant 10%	*	*		*	*	*	*

Concluding Remarks

- Economic and Financial Topics rather than Technical Details
- Yet, not all aspects can be covered
- Obstacles such as unavailability of data



Concluding Remarks

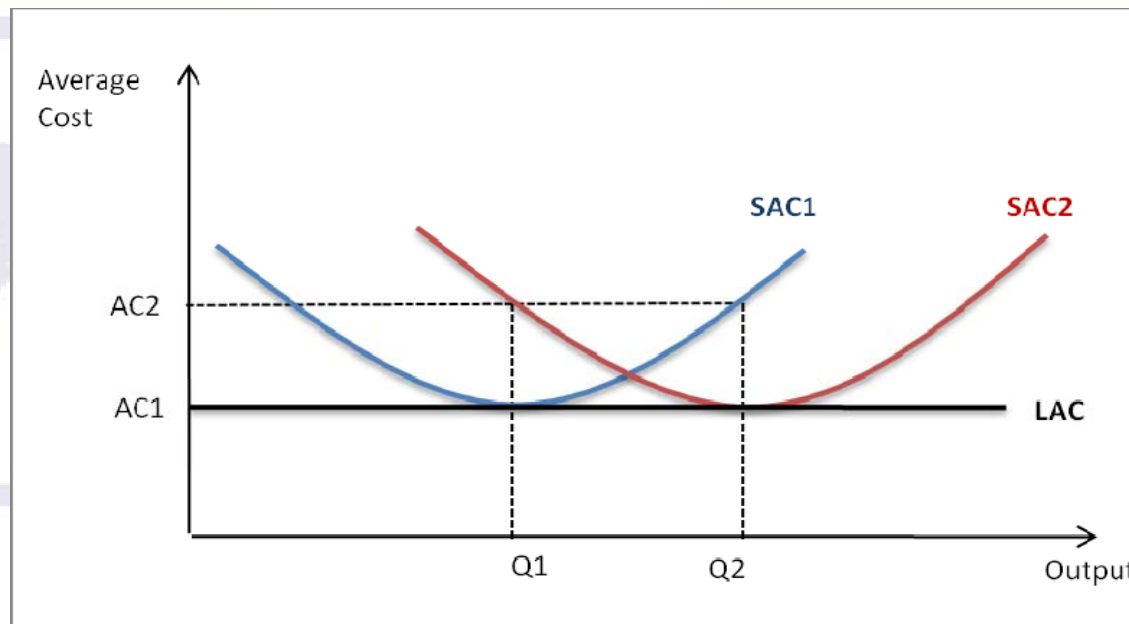
Importance of LCC Traffic

- Airports with excess capacity
- Extra demand with lower average costs

Importance of Capacity Expansion

- Different airports have different investment cycles
- Capacity expansion → less efficient for the following years

FIGURE 3: CAPACITY EXPANSION UNDER CRS



SOURCE: Morrison (2009)

Concluding Remarks

Importance of Capacity Expansion(Cont'd):

- Capacity Expansion corresponds future demand forecast:
→Wrong assumptions or external demand shocks

Importance of Mixed Public Ownership Structure:

- Number of public owners (federal government, states and cities)
→Conflict between different interest groups?

Importance of Regulation Type:

- Niemeier (2002): independent regulator, price-cap, dual-till

Importance of Staff Costs:

- Considered to be under the control of management
→In Germany, is it really the case?
→Strong labor unions (e.g. Frankfurt and Berlin strikes)

2- Ph.D. Thesis Proposal:

**Benchmarking Airports using
Congestion DEA and Investigating
How to Deal With Congestion**

Benchmarking Airports using Congestion DEA

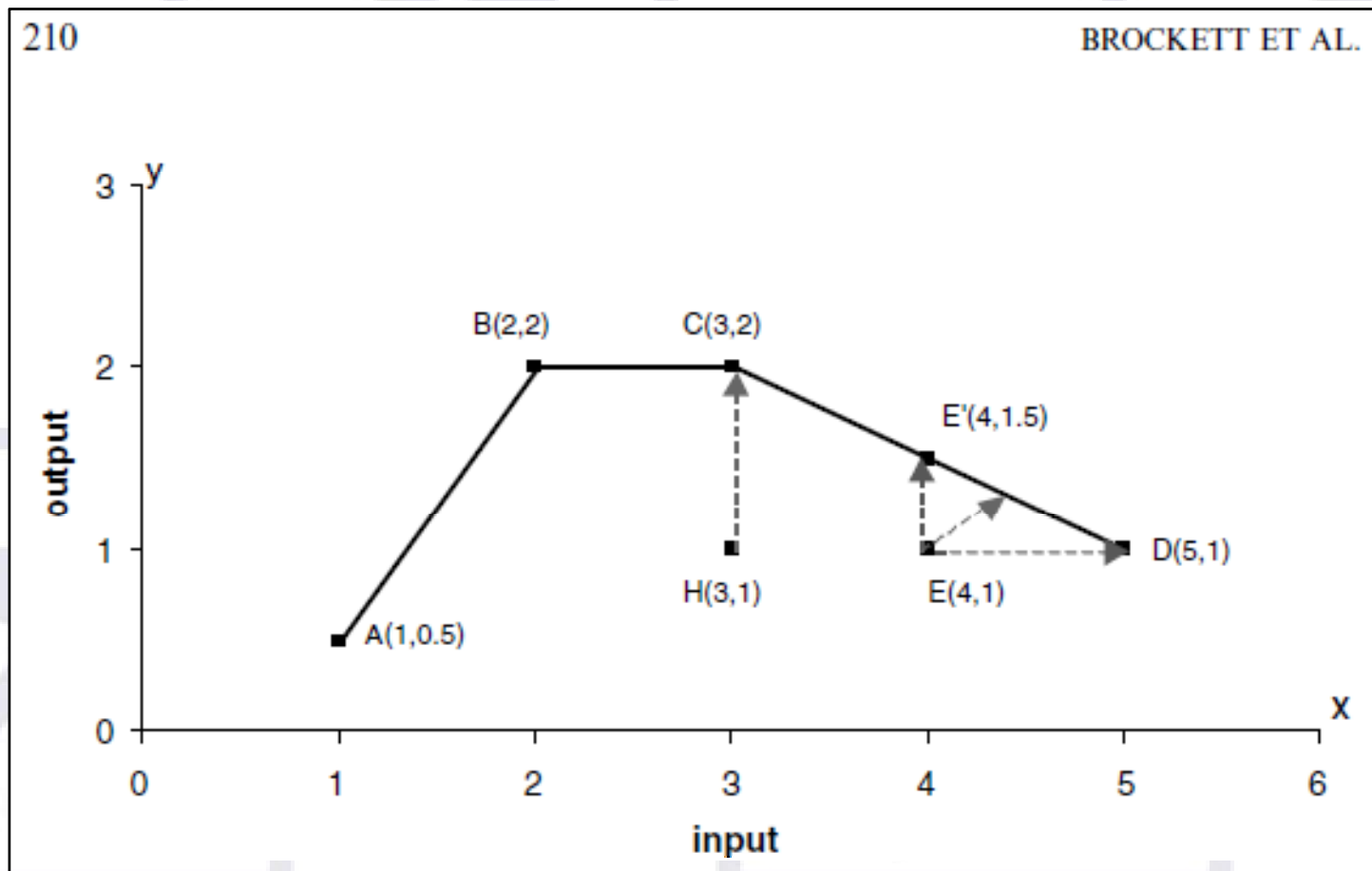
Motivation:

In ordinary DEA, the DMU's with no congestion are compared with the ones with congestion. Ex: DUS vs. BRE

Brockett et al. (2004):

DEA is used to identify congestion when the data show it to be present, estimate its amounts, and separate it from other forms of inefficiency.

Benchmarking Airports using Congestion DEA



→ From E' to C, input reduction, output increase

Benchmarking Airports using Congestion DEA

Preliminary Literature Review:

- Cooper et al. (2000): Theoretical Background
- Cherchye et al. (2001): Theoretical Background
- Tone et al. (2004): Congestion & Scale Economies
- Brockett et al. (2004):
- Barros et al. (2007): Empirical Study to determine congested airports.

Benchmarking Airports using Congestion DEA

A: Data Selection is Crucial:

1. Technical Data:

- Terminal & Runway System separately?
- How to accommodate some additional technical details, such as apron, labor bottlenecks?
- How big is the role of outsourcing?

Benchmarking Airports using Congestion DEA

A: Data Selection is Crucial:

2. Financial Data:

- If it makes sense?
- Capital, but which variables to use?

Benchmarking Airports using Congestion DEA

B:Sample Selection is Crucial

1.Only German Airports:

- There are not too many congested German Airports
- Very small sample

2. Focus on European Airports:

- Only consider the known congested airports
- Or, the whole sample?

Benchmarking Airports using Congestion DEA

What to do for more efficient operation?

1- Capacity Expansion:

- Applicability, due to constraints?
- Source of finance
- How much to invest

Zhang&Zhang (2001): Effects of Concession and Privatization

Benchmarking Airports using Congestion DEA

What to do for more efficient operation?

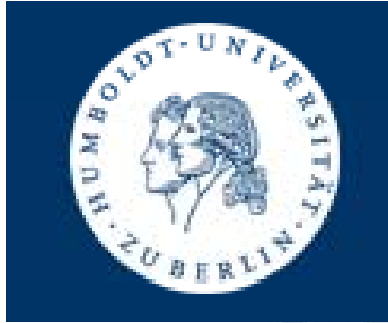
2- Congestion Pricing:

Oum&Zhang (1990): Airport Pricing

Daniel&Pahwa (1998): Congestion Pricing (3 cases)

Pels&Verhoef (2004): Congestion Pricing

Brueckner (2002): Market Power of Airlines & Congestion



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Thank you very much
for your attention!