Benchmarking Airports:
1- Overview of Master Thesis
2- Proposals for Ph.D. Thesis

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GARS Workshop “Benchmarking of Airports”
Berlin, 20 November 2009
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: Urbatzka & Wilken, 2004
Literature Review

1. Data Envelopment Analysis (DEA)
   - Gillen and Lall (2001)
   - 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)
   - Murillo-Melchor (1999)
   - Barros and Weber (2009)

3. Bootstrapped DEA
   - 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


- 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:

• Bootsrapped DEA : Bias-corrected efficiency scores
  → for Cost Efficiency

• Spearmen 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

\[ x = (x_1, \ldots, x_N) \rightarrow \text{Input vector} \quad y = (y_1, \ldots, y_N) \rightarrow \text{Output vector} \]

Production Technology:

\[ L(y) = \{x: x \text{ can produce } y\}, \quad y \in \mathbb{R}_+ \]

Shephard input distance function:

\[ D(y, x) = \sup \{ \lambda \in \mathbb{R} : (x / \lambda) \in L(y) \} \text{ w.r.t. } \lambda, \]

• Second Stage Truncated Regression

\[ TE_j \approx a + Z_j \delta + E_j \quad j = 1, \ldots, n, \]

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:

<table>
<thead>
<tr>
<th>Country</th>
<th>Airports</th>
<th>Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>1</td>
<td>98-05</td>
</tr>
<tr>
<td>Belgium</td>
<td>1</td>
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<td>Denmark</td>
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<td>France</td>
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<td>1</td>
<td>98-05</td>
</tr>
<tr>
<td>Norway</td>
<td>1</td>
<td>2000-2005</td>
</tr>
<tr>
<td>Switzerland</td>
<td>1</td>
<td>98-07</td>
</tr>
<tr>
<td>UK</td>
<td>17</td>
<td>98-06</td>
</tr>
<tr>
<td>Total</td>
<td>59</td>
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</table>

German Airports in the Analysis:

Between 1998 und 2007

<table>
<thead>
<tr>
<th>BER</th>
<th>CGN</th>
<th>DUS</th>
<th>HAM</th>
<th>NUE</th>
</tr>
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<tbody>
<tr>
<td>BRE</td>
<td>DTM</td>
<td>HAJ</td>
<td>MUC</td>
<td>STR</td>
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INPUTS

- Staff Costs
- Other Operating Costs
- Tangible Assets + Inventories

OUTPUTS

- PAX
- Cargo

Total 59
Results

1 – DEA EFFICIENCY SCORES:

1,000 → FULLY EFFICIENT LEVEL
Results

2- SPEARMEN RANK CORRELATION TEST:

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

FORMULA:

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

\[ r = 0.762 \] > 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

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<tr>
<td>Coefficient</td>
<td>2.6553</td>
<td>-0.3113</td>
<td>-0.5399</td>
<td>-0.3816</td>
<td>0.0341</td>
<td>-0.0381</td>
<td>5.3755</td>
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<tr>
<td>Significant 1%</td>
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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**

**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

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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 requieres higher costs and higher revenue → Cost efficiency is more sensitive
• DTM airport has a very high share of int‘l traffic

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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 \(\rightarrow\) 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):

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
Thank you very much for your attention!