Small regional airport sustainability: Lessons from benchmarking

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Outline

• Motivation
• Methodologies
• Efficiency Measurement
  ✓ airport observations
  ✓ variables
• Results
  ✓ DEA
  ✓ break-even point
  ✓ second stage regression
• Conclusions
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• Conclusions
Motivation

“An efficient airport provides important economic catalysts that enable the local and regional economy to thrive and improve the quality of life in the region.” (Oum et al., 2008)
Motivation

– Small and regional airports frequently suffer from:
  • limited traffic
  • fixed infrastructure requirements
  • insufficient revenues to cover their costs

– Subsidize loss-making airports
  1. Direct subsidies from local or federal government
  2. Cross-subsidization

– Question: how should such airports be structured, managed and financially supported in order to survive?
Regional accessibility and social development in Europe
Motivation

- Small regional airports should not be underestimated

  - In Europe*, in 2007, 340 out of 491 airports < 1.5 million PAX

(Source: EUROSTAT)

*The EU, Croatia, Turkey, Iceland, Norway and Switzerland

- Airport benchmarking literature focuses on:
  - Main large hubs
  - Country level
Aims of research

• to estimate relative efficiencies of regional airports across Europe

• to analyze efficiency changes over time

• to examine reasons for poor performance

• to provide recommendations to airport managers, airport operators, civil aviation authorities and governments
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• **Methodologies**

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DEA model

\[ \text{Max } Q = 1 - \frac{1}{m + s} \left( \sum_{i=1}^{m} \frac{S_{io}^-}{L_{io}^-} + \sum_{r=1}^{s} \frac{S_{ro}^+}{U_{ro}^+} \right) \]

s.t. \[ \sum_{j=1}^{n} x_{ij} \lambda_j + S_{io}^- = x_{io} \quad \forall \quad i = 1, \ldots, m \]
\[ \sum_{j=1}^{n} x_{kj} \lambda_j \leq x_{ko}^{ND} \quad \forall \quad k = 1, \ldots, l \]
\[ \sum_{j=1}^{n} y_{rj} \lambda_j - S_{ro}^+ = y_{ro} \quad \forall \quad r = 1, \ldots, s \]
\[ \sum_{j=1}^{n} y_{pj}^{ND} \lambda_j \geq y_{po}^{ND} \quad \forall \quad p = 1, \ldots, q \]
\[ \sum_{j=1}^{n} \lambda_j = 1 \]
\[ \lambda_j \geq 0 \quad \forall \quad j = 1, \ldots, n \]
\[ S_{io}^- \geq 0 \quad \forall \quad i = 1, \ldots, m \]
\[ S_{ro}^+ \geq 0 \quad \forall \quad r = 1, \ldots, s \]

BAM (Cooper et al., 2011)

- Slack-based (additive)
- Non-radial
- Non-oriented
- Non-discretionary variables
- Variable Returns to Scale
DEA model

\[
\text{Max} \quad Q = 1 - \frac{1}{m + s} \left( \sum_{i=1}^{m} \frac{S_{io}^{-}}{L_{io}^{-}} + \sum_{r=1}^{s} \frac{S_{ro}^{+}}{U_{ro}^{+}} \right)
\]

\[
s.t. \quad \sum_{j=1}^{n} x_{ij} \lambda_j + S_{io}^{-} = x_{io} \quad \forall \quad i = 1,\ldots, m
\]

\[
\sum_{j=1}^{n} x_{kj}^{ND} \lambda_j \leq x_{ko}^{ND} \quad \forall \quad k = 1,\ldots, l
\]

\[
\sum_{j=1}^{n} y_{rj} \lambda_j - S_{ro}^{+} = y_{ro} \quad \forall \quad r = 1,\ldots, s
\]

\[
\sum_{j=1}^{n} y_{pj}^{ND} \lambda_j \geq y_{po}^{ND} \quad \forall \quad p = 1,\ldots, q
\]

\[
\sum_{j=1}^{n} \lambda_j = 1
\]

\[
\lambda_j \geq 0 \quad \forall \quad j = 1,\ldots, n
\]

\[
S_{io}^{-} \geq 0 \quad \forall \quad i = 1,\ldots, m
\]

\[
S_{ro}^{+} \geq 0 \quad \forall \quad r = 1,\ldots, s
\]

**BAM (Cooper et al., 2011)**

- **DMU specific ranges**
  \[
  L_{io}^{-} = x_{io} - \bar{x}_i \quad \forall \quad i = 1,\ldots, m
  \]
  \[
  U_{ro}^{+} = y_r - y_{r0} \quad \forall \quad r = 1,\ldots, s
  \]

- **Ideal point**
  \[
  \underline{x}_j = \min \{x_{ij} \quad \forall \quad j = 1,\ldots, n\}
  \]
  \[
  \overline{y}_r = \max \{y_{rj} \quad \forall \quad j = 1,\ldots, n\}
  \]
Determination of break-even point

\[
\begin{align*}
TR_i &= P_i \cdot PAX_i + u_i \quad \forall \quad i = 1, \ldots, n \\
TC_i &= FC_i + VC_i \cdot PAX_i + e_i \quad \forall \quad i = 1, \ldots, n
\end{align*}
\]
Second stage regressions

- OLS Regression
- Truncated Regression
- (Censored) Tobit Regression

Robust results
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Regional and small airport dataset

85 airports from 6 countries:

- Austria, France, Germany, Italy, Norway and UK (Avinor)
  (incl. HIAL)
- Between 3,000 - 1,600,000 passengers annually
- Time Period: 2002-2009
Input and output variables

Inputs:

- labor costs
- other operating costs
- total runway length (ND)

Outputs:

- non-aeronautical revenues
- the number of passengers served (ND)
- commercial air traffic movements (ND)
- tons of cargo (ND)

Monetary values: PPP and inflation adjusted

ND: Non-discretionary
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## Percentage reductions / increases at country and airport group level

<table>
<thead>
<tr>
<th>Country / Airport Group</th>
<th>Number of Airports</th>
<th>Percentage Reduction in Staff Costs</th>
<th>Percentage Reduction in Other Operating Costs</th>
<th>Percentage Reduction in Total Costs</th>
<th>Percentage Increase in Non-aviation Revenues</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avinor</td>
<td>41</td>
<td>31%</td>
<td>56%</td>
<td>43%</td>
<td>23%</td>
</tr>
<tr>
<td>HIAL</td>
<td>9</td>
<td>58%</td>
<td>74%</td>
<td>65%</td>
<td>134%</td>
</tr>
<tr>
<td>UK</td>
<td>2</td>
<td>37%</td>
<td>28%</td>
<td>32%</td>
<td>-</td>
</tr>
<tr>
<td>Group</td>
<td>52</td>
<td>36%</td>
<td>58%</td>
<td>46%</td>
<td>41%</td>
</tr>
<tr>
<td>Austria</td>
<td>1</td>
<td>36%</td>
<td>12%</td>
<td>24%</td>
<td>-</td>
</tr>
<tr>
<td>France</td>
<td>22</td>
<td>47%</td>
<td>42%</td>
<td>45%</td>
<td>4%</td>
</tr>
<tr>
<td>Germany</td>
<td>2</td>
<td>72%</td>
<td>41%</td>
<td>58%</td>
<td>-</td>
</tr>
<tr>
<td>Italy</td>
<td>5</td>
<td>43%</td>
<td>42%</td>
<td>43%</td>
<td>6%</td>
</tr>
<tr>
<td>UK</td>
<td>3</td>
<td>59%</td>
<td>46%</td>
<td>52%</td>
<td>5%</td>
</tr>
<tr>
<td>Standalone</td>
<td>33</td>
<td>49%</td>
<td>41%</td>
<td>46%</td>
<td>4%</td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td>41%</td>
<td>51%</td>
<td>46%</td>
<td>27%</td>
</tr>
</tbody>
</table>
Break-even point

Break-even point for 85 sample airports.

<table>
<thead>
<tr>
<th></th>
<th>(1) Based on current data</th>
<th>(2) Based on hypothetically efficient airports</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2002</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fixed cost</td>
<td>1,500,222</td>
<td>4.2</td>
</tr>
<tr>
<td>Variable cost</td>
<td>8.13</td>
<td>10.2</td>
</tr>
<tr>
<td>Revenue</td>
<td>15.60</td>
<td>16.7</td>
</tr>
<tr>
<td><strong>2009</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fixed cost</td>
<td>2,558,790</td>
<td>7.2</td>
</tr>
<tr>
<td>Variable cost</td>
<td>10.47</td>
<td>16.5</td>
</tr>
<tr>
<td>Revenue</td>
<td>15.99</td>
<td>21.1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Critical level of passenger throughput</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2002</strong></td>
<td>200,832</td>
</tr>
<tr>
<td><strong>2009</strong></td>
<td>463,549</td>
</tr>
</tbody>
</table>
## Second stage regression

Second stage regression results explaining efficiency estimates.

<table>
<thead>
<tr>
<th>Ln(efﬁciency estimate)</th>
<th>Explanatory variables</th>
<th>OLS Coef.</th>
<th>t-stat.</th>
<th>Truncated Coef.</th>
<th>z-stat</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Managerial Variables</strong></td>
<td>Commercial rev &gt;50%</td>
<td>0.03</td>
<td>3.38</td>
<td>0.04</td>
<td>3.67</td>
</tr>
<tr>
<td></td>
<td>Ground handling or fuel sales in-house</td>
<td>−0.03</td>
<td>−5.96</td>
<td>−0.03</td>
<td>−6.16</td>
</tr>
<tr>
<td><strong>Non-Discretionary Variables</strong></td>
<td>Belongs to airport system</td>
<td>−0.05</td>
<td>−5.41</td>
<td>−0.05</td>
<td>−5.50</td>
</tr>
<tr>
<td></td>
<td>PSO served</td>
<td>0.03</td>
<td>4.53</td>
<td>0.04</td>
<td>4.46</td>
</tr>
<tr>
<td></td>
<td>Military involvement</td>
<td>0.02</td>
<td>1.76</td>
<td>0.02</td>
<td>1.74</td>
</tr>
<tr>
<td></td>
<td>Remote area</td>
<td>−0.03</td>
<td>−3.07</td>
<td>−0.03</td>
<td>−3.03</td>
</tr>
<tr>
<td></td>
<td>STOL</td>
<td>0.00</td>
<td>−0.21</td>
<td>0.00</td>
<td>−0.18</td>
</tr>
<tr>
<td></td>
<td>Public</td>
<td>0.01</td>
<td>1.19</td>
<td>0.01</td>
<td>1.13</td>
</tr>
<tr>
<td><strong>Partially discretionary</strong></td>
<td>Log EBIT</td>
<td>0.02</td>
<td>4.86</td>
<td>0.02</td>
<td>4.67</td>
</tr>
<tr>
<td><strong>Time dummies</strong></td>
<td>d2003</td>
<td>−0.04</td>
<td>−3.30</td>
<td>−0.05</td>
<td>−3.71</td>
</tr>
<tr>
<td></td>
<td>d2004</td>
<td>−0.07</td>
<td>−5.52</td>
<td>−0.08</td>
<td>−5.74</td>
</tr>
<tr>
<td></td>
<td>d2005</td>
<td>−0.08</td>
<td>−6.63</td>
<td>−0.10</td>
<td>−6.79</td>
</tr>
<tr>
<td></td>
<td>d2006</td>
<td>−0.08</td>
<td>−6.93</td>
<td>−0.10</td>
<td>−7.08</td>
</tr>
<tr>
<td></td>
<td>d2007</td>
<td>−0.08</td>
<td>−7.07</td>
<td>−0.10</td>
<td>−7.34</td>
</tr>
<tr>
<td></td>
<td>d2008</td>
<td>−0.09</td>
<td>−7.66</td>
<td>−0.11</td>
<td>−7.92</td>
</tr>
<tr>
<td></td>
<td>d2009</td>
<td>−0.10</td>
<td>−8.29</td>
<td>−0.12</td>
<td>−8.34</td>
</tr>
<tr>
<td></td>
<td>Constant</td>
<td>−0.45</td>
<td>−5.68</td>
<td>−0.42</td>
<td>−5.14</td>
</tr>
</tbody>
</table>
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Conclusions

• Reduce costs & increase commercial revenues
  → Potential for some airports even to achieve break-even point (144 out of 696 obs.)

• Operational costs increasing in Europe over decade
  → Need to further analyze security management

• Airport groups are less efficient
  → Individual management better utilizes resources according to regional needs

• Subsidies should be performance based
  → Improve incentives for productive efficiency

• Outsource all ground handling activities

• Need for continuous benchmarking
Thank you for your attention.