A new direct demand model of long-term forecasting air passengers and air transport movements at German airports

Peter Berster, Dieter Wilken & Marc C. Gelhausen
Agenda

• Classical Four-Step Model of DLR Passenger Demand & Flights Forecast of Germany

• New Direct Demand and Flight Model

• Conclusions
The Development of Global Gross Domestic Product (GDP) and Air Traffic (Passengers and Freight)
Development of Air Passenger Demand of Germany 1991 to 2015 by Trip Purpose
### Segment Specific Model Approaches of Forecasting Air Passenger Demand of Germany

#### Air Transport Demand Segments of Germany

<table>
<thead>
<tr>
<th>Domestic Air Journeys</th>
<th>Border Crossing Air Journeys</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Forecast Model Approach</strong></td>
<td><strong>Business Journeys</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Originating Travel</strong></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Influencing Variables</strong></td>
<td>Economic development, employment</td>
</tr>
<tr>
<td><strong>General Forecast Hypotheses</strong></td>
<td>Continuous development of society and economy in Germany and worldwide; further liberalisation and globalisation of transport; no capacity restraints in the air transport system; no basic change in the consumption behaviour.</td>
</tr>
<tr>
<td><strong>Structure 2014</strong></td>
<td>11</td>
</tr>
</tbody>
</table>
Air Traffic & Socio-Economic Data and Non-Stationarity: Cointegration Approach

[Graph showing growth rates of various indicators over years, with legends for different datasets including flight growth at German airports, GDP growth in the European Union, passenger growth at German airports, passenger per flight growth rate at German airports, and linear trends for each.]
Objective of the direct demand model

- To model and predict future passengers at German airports
- In a way that the forecast is “as precise as possible”
- It is not the prime objective of this model to provide a model of individual air travellers’ behaviour
- Analyse the impact of past crisis on passenger demand at German airports
Actual Time Series and Ex-post Forecast of the Passenger Model

- Effects of German Unity
- 9/11
- Sub-Prime Crisis
- Arab Spring in Egypt

Annual growth rate of passengers at German airports

- Lufthansa fleet renewal

R² = 97.3%
ADF statistic (Residuals) = -6.68

- Predicted passenger growth at German airports
- Passenger growth at German airports
- Residuals
## Estimation Results of the Passenger Model

<table>
<thead>
<tr>
<th></th>
<th>Coefficients</th>
<th>Standard error</th>
<th>t Stat</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-0.01029747</td>
<td>0.004065447</td>
<td>-2.53292334</td>
<td>0.022961765</td>
</tr>
<tr>
<td>GDP growth rate in EU (in %)</td>
<td>1.33864893</td>
<td>0.119364016</td>
<td>11.2148449</td>
<td>1.08373E-08</td>
</tr>
<tr>
<td>Growth rate of passengers per flight (in %)</td>
<td>0.88189283</td>
<td>0.086731874</td>
<td>10.1680361</td>
<td>4.01135E-08</td>
</tr>
<tr>
<td>German Unity</td>
<td>0.38154884</td>
<td>0.037471924</td>
<td>10.182259</td>
<td>3.93795E-08</td>
</tr>
<tr>
<td>9/11 Attacks (2001 &amp; 2002)</td>
<td>-0.0361058</td>
<td>0.007640279</td>
<td>-4.72571692</td>
<td>0.00027065</td>
</tr>
<tr>
<td>Post 9/11 &amp; SARS (2004 &amp; 2005)</td>
<td>0.02138957</td>
<td>0.007003294</td>
<td>3.05421484</td>
<td>0.008034097</td>
</tr>
<tr>
<td>Post Sub-Prime Crisis (2011 &amp; 2012)</td>
<td>0.02369593</td>
<td>0.007791007</td>
<td>3.04144679</td>
<td>0.008246059</td>
</tr>
<tr>
<td>Arab Spring in Egypt (2012 &amp; 2013)</td>
<td>-0.03286561</td>
<td>0.008291649</td>
<td>-3.96370023</td>
<td>0.001248201</td>
</tr>
</tbody>
</table>

- **Blue**: Primary explanatory variables
- **Green**: Secondary explanatory variables ("Shocks")
Actual Time Series and Ex-post Forecast of the Flight Model

![Graph showing annual growth rate of flights at German airports from 1992 to 2014.](image)

- **Results are based upon correct (historical) passenger growth rate!**

  - Annual growth rate of flights at German airports

  - Year:
    - 1992
    - 1993
    - 1994
    - 1995
    - 1996
    - 1997
    - 1998
    - 1999
    - 2000
    - 2001
    - 2002
    - 2003
    - 2004
    - 2005
    - 2006
    - 2007
    - 2008
    - 2009
    - 2010
    - 2011
    - 2012
    - 2013
    - 2014

- **$R^2 = 100\%$**

- **ADF statistic (Residuals) = -4.59**

- **Legend:**
  - Blue line: Predicted flight growth at German airports
  - Green line: Flight Growth at German airports
  - Red line: Residuals

---

**Source:** DLR
## Estimation Results of the Flight Model

<table>
<thead>
<tr>
<th></th>
<th>Coefficients</th>
<th>Standard error</th>
<th>t Stat</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>0.00101816</td>
<td>0.000158633</td>
<td>6.41832508</td>
<td>3.73633E-06</td>
</tr>
<tr>
<td>Passenger growth rate (in %)</td>
<td>0.96938002</td>
<td>0.002660059</td>
<td>364.420474</td>
<td>5.41996E-38</td>
</tr>
<tr>
<td>Growth rate of passengers per flight (in %)</td>
<td>-0.99995844</td>
<td>0.004546426</td>
<td>-219.943852</td>
<td>7.93493E-34</td>
</tr>
<tr>
<td>9/11 Attacks (2001 &amp; 2002)</td>
<td>-0.00208076</td>
<td>0.000372562</td>
<td>-5.58498967</td>
<td>2.18981E-05</td>
</tr>
</tbody>
</table>

*Flight volume growth rate = Passenger volume growth rate – Growth rate of passengers per flight*
Conclusions

- Both model approaches have their strength and weaknesses:
  - The classical approach emphasises cross-sectional issues, e.g. differences in travel behaviour
  - The direct demand and flight model emphasises longitudinal issues, e.g. cointegration & shocks
  - Further aspects: Data requirements, statistical significance of results, top-down vs. bottom-up, ...

- The new approach allows for an analysis and quantification of shocks, like e.g. 9/11, to the air transport system, which is a first step towards forecasting such shocks over the long-term

- Future research includes how to combine these two approaches effectively
Thank you for your attention!

Contact:
Dr. Marc C. Gelhausen
DLR - German Aerospace Center
Air Transport and Airport Research
Linder Hoehe
51147 Cologne/Germany

Marc.Gelhausen@dlr.de
Tel: +49 2203 601 2463