European route choice determinants

Examining fuel and route charge trade-offs

Luis Delgado
Senior Research Fellow
University of Westminster
Overview

• Background

• Methodology
  – Data
  – Reference route
  – Fuel estimation

• Analysis
  – Routes distance
  – Charges and fuel
  – Examples
  – Parameters

• Conclusions
Background
Background

- **ATFM regulations**
  - Deal with capacity/demand imbalance
  - Aircraft operators assigned delay. Small involvement on the solution

- **Market based solutions**
  - Monetise the use of congested airspace

- Model airlines behaviour when different charges possible
- Impact on current route preferences and traffic forecast
Background

• European charging zones

\[
R = \sum r_i
\]

Individual charge
\[
r_i = d_i \times p \times t_i
\]

Unit rate
\[
t_i
\]

Distance
\[
d_i = \frac{Entry - Exit \; pts \; GCD(km)}{100}
\]

Weight factor
\[
p = \sqrt{MTOW/50}
\]
Example route selection considering en-route charges

**Route A:**
- CHT
- 68 NM shorter
- 2,110 EUR charges
- 352 EUR more expensive

**Route B:**
- LCC
- 53 NM longer flown
- 1,758 EUR charges
- 352 EUR savings
- Higher fuel consumption?

Understand what parameters drive route selection when selecting a route with respect to the en-route charges.
Methodology
- Data
Data

- 12th September 2014 traffic
  - EUROCONTROL data demand repository (DDR2) dataset
  - Intra-European flights overflying en-route charges areas
  - Flight classification
    - Full service (FSC)
    - Low-cost carriers (LCC)
    - Charter flights (CHT)
    - Regional flights (REG)
  - Commercial passenger flights
  - Circular/diverted flights not considered
Data

- 12th September 2014 traffic
  - 33,810 flights to-from Europe
  - 13,496 flights (39.9%) within Europe with en-route charges computed
  - 10,331 flights (30.6%) with fuel consumption estimated
Methodology
- Reference route
Reference route

- Route planning / Execution

Airspace information

FUA/CDR - Airspace constraints

Weather – En-route charges – Other op. const.

ATFM regulations

Tactical modifications – CDR 3 routes

Origin – Destination Great Circle Distance

Shortest route without constraints

Shortest Constrained Route (SCR)

Filed Tactical Flight Model (FTFM)

Regulated Tactical Flight Model (RTFM)

Current Tactical Flight Model (CTFM)
Reference route

Routes

- Origin – Destination
  Great Circle Distance

- Shortest route without constraints

- Shortest Constrained Route (SCR)

- Filed Tactical Flight Model (FTFM)

- Regulated Tactical Flight Model (RTFM)

- Current Tactical Flight Model (CTFM)

Considered reference route

Used to compute en-route charges

Flown route distance
Methodology
- Fuel estimation
Fuel estimation

Route
- Average cruise speed
- Average Flight Level

Reference route
- BADA cruise speed

BADA model

Fuel consumption estimated
Reference route fuel consumption estimated
Analysis
- Routes distance
Routes distances

- Extra distance selected vs. airspace charges

<table>
<thead>
<tr>
<th>Extra Distance</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>83.4%</td>
</tr>
<tr>
<td>4</td>
<td>4.6%</td>
</tr>
<tr>
<td>10</td>
<td>6.4%</td>
</tr>
<tr>
<td>20</td>
<td>5.6%</td>
</tr>
</tbody>
</table>
Routes distances

- Extra distance selected vs. airspace charges
Routes distances

- Extra distance selected vs. extra distance flown

63%
Routes distances

- Extra distance flown vs. airspace charges
Analysis
- Charges and fuel
Charges and fuel

- Extra fuel vs. airspace charges
Analysis
- Examples
Examples

LGSA – EGNX

<table>
<thead>
<tr>
<th>Δ En-route charges (EUR)</th>
<th>-344</th>
</tr>
</thead>
<tbody>
<tr>
<td>Δ Fuel consumption (EUR)</td>
<td>-537</td>
</tr>
<tr>
<td>Δ Total cost</td>
<td>-881</td>
</tr>
<tr>
<td>Airline type</td>
<td>LCC</td>
</tr>
</tbody>
</table>
Examples

<table>
<thead>
<tr>
<th>Δ En-route charges (EUR)</th>
<th>-222</th>
</tr>
</thead>
<tbody>
<tr>
<td>Δ Fuel consumption (EUR)</td>
<td>255</td>
</tr>
<tr>
<td>Δ Total cost</td>
<td>33</td>
</tr>
<tr>
<td>Airline type</td>
<td>LCC</td>
</tr>
</tbody>
</table>

LTFG – EHAM

11th USA/Europe ATM Seminar
Lisbon, 23 – 26 JUN 2015
Examples

<table>
<thead>
<tr>
<th>Δ En-route charges (EUR)</th>
<th>-456</th>
</tr>
</thead>
<tbody>
<tr>
<td>Δ Fuel consumption (EUR)</td>
<td>247</td>
</tr>
<tr>
<td>Δ Total cost</td>
<td>-209</td>
</tr>
<tr>
<td>Airline type</td>
<td>FSC</td>
</tr>
</tbody>
</table>
Examples

<table>
<thead>
<tr>
<th>Δ En-route charges (EUR)</th>
<th>121</th>
</tr>
</thead>
<tbody>
<tr>
<td>Δ Fuel consumption (EUR)</td>
<td>-268</td>
</tr>
<tr>
<td>Δ Total cost</td>
<td>-147</td>
</tr>
<tr>
<td>Airline type</td>
<td>LCC</td>
</tr>
</tbody>
</table>

LROP – LIPE
Examples

Maastricht Upper Area Control Centre

- EH not in the SCR but filled: 41 flights
- EH in SCR but not used: 21 flights
Examples

Maastricht Upper Area Control Centre
Analysis
- Parameters
Parameters

- Difference in distance flown with respect to filed vs. flight plan distance
Parameters

• FSC and hub operations
Parameters

- Cost variability by aircraft operator type
Parameters

• Extra fuel vs. airspace charges by aircraft operator type
Conclusions
Conclusions

• En-route charges play a role on route selection
• Selection of cheaper airspace based on *opportunity*
• Other parameters (e.g. regulations) might drive route selection
• Unit rates as in April 2015 have increase differences in some surrounding airspaces with respect to values in September 2014
  – Example: Germany increase unit rate by 16.5%, Belgium by 1.9%, Netherlands by 0.1%, Poland by -0.87%
  – Increase of traffic on some airspace (e.g. MUAC) unevenly distributed due to airspace charges (e.g. MUAC increase in traffic 2.2%: 4.8% Brussels airspace, 2.0% Deco airspace and -2.0% Hannover airspace)
Conclusions

• Filed route can be significantly shifted with respect to shortest route available
• This has an impact on airspace usage predictability
• Aircraft operator behaviour is complex
  – No direct relationship between aircraft operator type and route preference
• Actual route flown in the majority of the cases shorter than filed route
Next steps
Next steps

• Need to incorporate IFPS route
• Fuel consumption reviewed
• Effect of meteorology (i.e., wind) should be incorporated
• Factor analysis technique
Thank you