Controller time and delay costs
a trade-off analysis
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Overview

• Background
• Methodology
  – Data
  – Costs modelling
  – ATCO availability
  – Adding extra ATCO hours rules
• Analysis and results
  – Regulations costs
  – Mechanism analysis
• Conclusions
Background
Background

Mechanism(s)
- Adding extra ATCO hours
- Dynamic cost indexing
- A-CDM
- Improved airline passenger reaccommodation policies

Indicators
- Staff capacity shortage (ATCO)
- Industrial actions (ATC)
- Meteorological events with local effects at airports

Stakeholders
- Airlines
- ANSPs
- Airports
- ...
Background

• Average daily en-route ATFM delay increased by 17.4%:
  – ATC Capacity (+27.8%)
  – En-route ATC staffing (+44.9%)
  – En-route weather (+23%)
Background

2014

• Average daily en-route ATFM delay increased by 17.4%:
  – ATC Capacity (+27.8%)
  – En-route ATC staffing (+44.9%)
  – En-route weather (+23%)

• 9,163 aircraft affected
• 88,900 K min delay (average 9.7 min/ac)
• EUR 4.3 M delay

Adding extra ATCO hours

Strategic operations
  (e.g. sectorisation)
Methodology

- Data
Data

- Demand Data Repository 2 (DDR2)
  - AIRAC 1313 to AIRAC 1413 (12DEC13 to 07JAN15)
  - Traffic data
    - 1,349,217 flights went through a regulation in total
    - 1,304,607 flights in scope
      - MTOW >= 15 tonnes
      - Military and cargo excluded
  - ATFM regulation data
    - Duration
    - Location
    - Reason
  - ACC data
    - Regulations by ACC
    - ATCO available
Methodology
- Costs modelling
Cost modelling

• Airline delay cost
  – 2014 values for at gate cost [1]
  – Explicit values for 15 core aircraft
    • covering 63% movements in ECAC area
  – Other aircraft fit of cost with \sqrt{\text{MTOW}}\)

Cost modelling

• ATCO costs
  – Only ATCO hours cost considered
    • (pre-)tactical level
  – Values of ATCO duty-hour cost from [2]

Methodology
- ATCO availability
ATCO availability

• From a tactical perspective
  – Flexible rostering
  – Controller mobility

• Staff shortages
  – Delays

• Over-staffing
  – Cost inefficiencies
Methodology
- Adding extra ATCO hours rules
Adding extra ATCO rules
Adding extra ATCO rules

Bounded by maximum number of ATCO for the ACC
Adding extra ATCO rules

- Two rules:

<table>
<thead>
<tr>
<th>Rule</th>
<th>Description</th>
<th>Benefit</th>
<th>Drawback</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rule 1</td>
<td>Fractional-shift ATCO</td>
<td>Extra controller only added</td>
<td>Allows fractional hours to be added</td>
</tr>
<tr>
<td></td>
<td></td>
<td>before start and after end of</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>regulation</td>
<td></td>
</tr>
<tr>
<td>Rule 2</td>
<td>Full-shift ATCO</td>
<td>Minimum number of ATCO hours</td>
<td>No optimisation of opening schemes/rostering</td>
</tr>
<tr>
<td></td>
<td></td>
<td>added, maximum theoretical</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>efficiency as baseline</td>
<td></td>
</tr>
</tbody>
</table>

Graph showing ATCO availability over time (UTC). The graph displays the number of ATCOs available from 0900 to 2100 UTC, with different colors representing the number of ATCOs available during regular and non-regular periods.
Analysis and results
- Regulations costs
Regulation costs

- 22,850 ATFM regulations
- 9.8M minutes delay

- Delay generated

- Cost generated

- Primary delay (reactionary not considered)

- 3.2M min airport
- 6.6M min en-route
- EUR 156M
- EUR 333M en-route

- Average 55 EUR/min
Regulation costs

- 5.7% regulations
- 6.8% ATFM delay
- EUR 30 M

Most penalising regulation
Regulation costs

- Regulations applied to airspace with more than one configuration
  - 1,112 regulations due to staff shortage (64 did not generate delay)
  - 80,930 flights
    - 33,648 with delay assigned (30,095 commercial flights)
    - Average 18 min per delayed flight
    - EUR 26M due to delay
      - average 50 EUR/min
Regulation costs

7,229 flights
14 min/flight

4,979 flights
21 min/flight

7 229 flights
14 min/flight

4 979 flights
21 min/flight

Regulation costs

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Regulation costs

Top 50 regulations by delay cost

![Graph showing regulation costs and other metrics](image-url)
Regulation costs

By ANSP
Regulation costs

By ANSP
Regulation costs

By ANSP
Regulation costs

By ACC
Regulation costs

By regulation

![Graph showing regulation costs vs delay]
Analysis and results
- Mechanism analysis
Mechanism analysis

• ATCO available
  – 1 112 regulations under study

• 198 regulations (17.8%) some period with maximum ATCOs
Mechanism analysis

- **ATCO available**
  - 1112 regulations under study
- 198 regulations (17.8%) some period with maximum ATCOs
- 60 regulations (5.4%) maximum number ATCO during whole regulation
Mechanism analysis

- ATCO available
  - 1,112 regulations under study
    - 198 regulations (17.8%) some period with maximum ATCOs
    - 60 regulations (5.4%) maximum number ATCO during whole regulation
    - 914 regulations (82.2%) below maximum number ATCO
- If controllers added → regulation can be averted
Mechanism analysis

- KUR1C20 – AIRAC 1410

- 121 minutes delay
- EUR 5,251
Mechanism analysis

- **KUR1C20 – AIRAC 1410**

  **Rule 1**

  ![Graph 1: Regulation KWUR1C20-1410 Delay: 121min](image1)

  **Rule 2**

  ![Graph 2: Regulation KWUR1C20-1410 Delay: 121min](image2)
Mechanism analysis

- EPJ R14N– AI RAC 1407

- 9 minutes delay
- EUR 390
Mechanism analysis

- EPJ R14N– AIRAC 1407

Rule 1

Rule 2
## Mechanism analysis

- **Three possibilities**

<table>
<thead>
<tr>
<th>Possibility</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Net gain</td>
<td>Delay cost is high enough as to justify adding ATCOs up to the maximum for the ACC</td>
</tr>
<tr>
<td>Net loss</td>
<td>Adding ATCOs leads to higher costs than the delay cost</td>
</tr>
<tr>
<td>Trade-off</td>
<td>With smaller number of controllers their cost is off-set by the cost of the delay avoided, whereas adding more controllers leads to higher net cost than the avoided delay</td>
</tr>
</tbody>
</table>
Mechanism analysis

• Results

<table>
<thead>
<tr>
<th>Rule</th>
<th>Net gain</th>
<th>Net loss</th>
<th>Trade-off</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>87.1% (969)</td>
<td>5.8% (64)*</td>
<td>1.7% (19)</td>
</tr>
<tr>
<td>2</td>
<td>72.7% (808)</td>
<td>13.4% (149)*</td>
<td>8.5% (95)</td>
</tr>
</tbody>
</table>

* 56 regulations in these categories do not have delay
Conclusions
Conclusions

• Average cost of delay per minute of ATFM delay useful at aggregated level (e.g. ANSP)

• Characteristics of delay have an impact on cost generated
  – Should be considered when applying mitigation mechanism
  – Even at aggregated level: 48 EUR/min per delay for aerodrome capacity vs. 96 EUR/min per delay for industrial actions

• In majority of cases, cost of delay generated justify adding ATCO resources

• Different stakeholder bearing the cost (ANSPs) than obtaining the benefit (Airlines and Passenger)

• Adding ATCO hours might also impact other KPIs such as productivity
Further work

• Modelling of the capacity increment by adding ATCOs should be carried out
• In some cases regulation might not be completely averted, but reduced in duration and/or intensity
• Further research needed to model characteristics of delay generated by regulations
Thank you
Mechanism analysis

• ATCO available
  – Average 4.3 ATCOs shortage with respect to maximum ACC
  – Average 2.4 ATCOs shortage within 4 h before and after regulation
  – 1 112 regulations under study
• 198 regulations (17.8%) some period with maximum ATCOs