Is it possible to mitigate airspace congestion by applying demand management in the strategic phase?

Research proposal: study and test effective methods for operating demand management through pricing (i.e., market-based methods).

Modulation of charges is already present in EU regulation:

EU Reg. 391/2013 art. 16:
“Member States, [...] may, at national or functional airspace block level and on a non-discriminatory and transparent basis, modulate air navigation charges [...] according to the level of congestion of the network”
In 2012, eight ACCs in Europe recorded an average en-route ATFM delay of over one minute per flight for more than 30 days (1).

At the current rate of growth, air traffic in Europe is estimated to increase by 50% in the next 20 years (2)

Avg. ATFM delay cost: 83€ per minute (incl. direct costs, network effect, estim. passenger loyalty retention costs for airlines (3)

Demand/capacity imbalances are only going to aggravate...

AIRSPACE CAPACITY MANAGEMENT IN EUROPE TODAY

No check on sector capacity before the tactical phase (on avg. 12h before operations).

Strategic
- Airport Time Slot Allocation

Tactical
- Air Traffic Flow Management

Operational
- Air Traffic Control
MARKET-BASED DEMAND MANAGEMENT IN NETWORK INDUSTRIES

- Market-Based Demand Management (MBDM) applied successfully in several network industries (NI).

- Examples:
  - Congestion charges in urban road networks;
  - Peak load pricing in public transports;
  - QoS pricing in telecommunications;
  - Locational Marginal Prices in electricity wholesale;
  - Credit-based pricing for electricity retail.

Can we “borrow” suitable pricing principles from other network industries and apply them to the European airspace?
Analysis of pricing techniques in network industries

Definition of a Framework for classifying pricing techniques

Definition of plausible scenarios for European airspace

Identification of suitable pricing options within each scenario
Studied network industries:
- data transmission,
- electricity wholesale and retail,
- urban road transport,
- rail transport.

Approx. 10 pricing methods per industry analysed and classified according to a simplified set of criteria.
## Classification Framework: Criteria

<table>
<thead>
<tr>
<th>Environment-related</th>
<th>Pricing-related</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Control</td>
<td>Centralised/Distributed</td>
</tr>
<tr>
<td>2. Pricing strategy objective</td>
<td>Max revenue/Cost recovery</td>
</tr>
<tr>
<td>3. Type of tariff</td>
<td>Flat, proportional to marginal costs etc.</td>
</tr>
<tr>
<td>4. Modulation of the tariff</td>
<td>Variation in time and/or space</td>
</tr>
<tr>
<td>5. Users classification</td>
<td>Presence/absence of user classes</td>
</tr>
<tr>
<td>6. Price setting strategy</td>
<td>resource value, willingness to pay etc.</td>
</tr>
<tr>
<td>7. Payment</td>
<td>Monetary, credits, permits etc.</td>
</tr>
<tr>
<td>8. Quality of Service (QoS)</td>
<td>Guaranteed/capped /compensation for denial of service</td>
</tr>
</tbody>
</table>
RECURRENT PRICING METHODS IN NETWORK INDUSTRIES

Pricing Principle

- Marginal Cost pricing
  - Real time pricing
    - Flat pricing
  - Consumption-proportional p.
    - Ramsey pricing
- Second-best pricing
- Auction-based
  - Bid pricing
- Peak-load pricing
RECURRENT PRICING METHODS IN NETWORK INDUSTRIES

Pricing Principle
- Marginal Cost pricing
- Second-best pricing
- Auction-based

Real-time pricing
- Flat pricing
- Consumption-proportional pricing
- Ramsey pricing

Peak-load pricing

Users are charged proportionally to the current cost of the resource.

Used in: electricity retail (real time pricing)

E.g., electricity retail (real time pricing)
E.g., telecommunications ("all you can eat" data plans), public transports (monthly ticket)
RECURRENT PRICING METHODS IN NETWORK INDUSTRIES

**Pricing Principle**

- Marginal Cost pricing
- Real time pricing
- Flat pricing
- Consumption-proportional pricing
- Ramsey pricing
- Peak-load pricing

- Second-best pricing
- Bid pricing

Users are charged a fixed amount for unlimited access to the resource.

Used in: data networks (“all you can eat” data plans), public transports (monthly ticket)
RECURRENT PRICING METHODS IN NETWORK INDUSTRIES

- Marginal Cost pricing
- Real time pricing
- Flat pricing
- Consumption-proportional pricing
- Ramsey pricing
- Peak-load pricing
- Second-best pricing
- Auction-based pricing

Users are charged proportionally to resource consumption.

Used in: European air transport (en-route charges), electricity retail (KWh-based rate).
RECURRENT PRICING METHODS
IN NETWORK INDUSTRIES

Pricing Principle

Marginal Cost pricing

Real time pricing

Flat pricing

Consumption-proportional p.

Ramsey pricing

Peak-load pricing

Second-best pricing

Auction-based

Bid pricing

Prices are inversely proportional to elasticity of customers’ demand \((\text{inverse elasticity rule})\).

Used in: data transm.. (responsive pricing), electricity retail (critical peak pricing).
RECURRENT PRICING METHODS IN NETWORK INDUSTRIES

**Pricing Principle**
- Marginal Cost pricing
- Second-best pricing
- Auction-based
- Real time pricing
- Flat pricing
- Consumption-proportional pricing
- Ramsey pricing
- Bid pricing
- Peak-load pricing

Simplified version of RP applied when congestion is easy to predict. Users are charged a higher fee during heavy load periods or in congested areas.

Used in: all NI.
RECURRENT PRICING METHODS IN NETWORK INDUSTRIES

Pricing Principle

- Marginal Cost pricing
- Real time pricing
- Flat pricing
- Consumption-proportional p.
- Ramsey pricing
- Peak-load pricing
- Auction-based
- Bid pricing

Users are charged increasingly as resource is consumed.

Used in: air and rail transport (seat inventory rev. management)
### Current Pricing Policy in Europe: Scenario 0

#### Centalised environment, no demand management.

<table>
<thead>
<tr>
<th>Environment has</th>
<th>Pricing is</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Control</td>
<td>3. Type of tariff</td>
</tr>
<tr>
<td>Decentralised: unit rates set by ANSPs, collected by EUROCONTROL.</td>
<td>4. Modulation of the tariff</td>
</tr>
<tr>
<td>2. Pricing strategy objective</td>
<td>5. Users classification</td>
</tr>
<tr>
<td>Cost recovery: en-route charges recover operational costs of ANSP for ATC services.</td>
<td>6. Price setting strategy</td>
</tr>
<tr>
<td>7. Payment</td>
<td></td>
</tr>
<tr>
<td>Monetary</td>
<td></td>
</tr>
<tr>
<td>8. Quality of Service (QoS)</td>
<td></td>
</tr>
<tr>
<td>Guaranteed service, capped by ATC sector (ATFM delay)</td>
<td></td>
</tr>
</tbody>
</table>

(*) = although EU reg. 391/2013 art. 16 allows unit rate modulation
Centalised environment, market-based demand management.

<table>
<thead>
<tr>
<th>Environment has</th>
<th>Pricing is</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Control</strong></td>
<td>Centralised control: Network Manager.</td>
</tr>
<tr>
<td><strong>2. Pricing strategy objective</strong></td>
<td>Cost recovery &amp; congestion reduction.</td>
</tr>
<tr>
<td><strong>3. Type of tariff</strong></td>
<td>Proportional to travelled distance, sector forecast capacity or both;</td>
</tr>
<tr>
<td><strong>4. Modulation of the tariff</strong></td>
<td>Space dependent, either time dependent or invariant.</td>
</tr>
<tr>
<td><strong>5. Users classification</strong></td>
<td>Equity is a priority; no users classes</td>
</tr>
<tr>
<td><strong>6. Price setting strategy</strong></td>
<td>Prices set according to resource value: cost of ATC services.</td>
</tr>
<tr>
<td><strong>7. Payment</strong></td>
<td>Either monetary or hybrid.</td>
</tr>
<tr>
<td><strong>8. Quality of Service (QoS)</strong></td>
<td>Guaranteed service, capped by estimated ATC sector capacity</td>
</tr>
</tbody>
</table>
PRICING OPTIONS FOR SCENARIO 1

1. **Marginal Cost Pricing**
   - Real time pricing
   - Not functional for strategic demand management
   - Not functional for demand management.

2. **Second-best Pricing**
   - Consumption-proportional pricing
   - Suitable if congestion-dependent.
   - Suitable issue: estimating customer elasticity

3. **Ramsey Pricing**
   - Suitable issue: guar. equity among users

4. **Flat Pricing**

5. **Auction-based Pricing**
   - Bid pricing

6. **Peak-load Pricing**
### APPLYING MBDM – SCENARIO 2

A decoupling of the demand for and supply of air traffic services occurs, which allows a market-based demand management (MBDM) system to be implemented. In this scenario, the environment is characterized by:

**Decentralised, Competitive/collaborative environment, market-based demand management.**

<table>
<thead>
<tr>
<th>Environment has</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Control</td>
<td>Market-based control with regulator: ANSPs + Network Manager</td>
</tr>
<tr>
<td>2. Pricing strategy objective</td>
<td>Cost recovery &amp; congestion reduction: each ANSP is responsible for its own airspace.</td>
</tr>
</tbody>
</table>

**Pricing is**

<table>
<thead>
<tr>
<th>Pricing is</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>3. Type of tariff</td>
<td>Proportional to travelled distance/sector forecast capacity/both.</td>
</tr>
<tr>
<td>4. Modulation of the tariff</td>
<td>All combinations of time and space, dependent and invariant are suitable.</td>
</tr>
<tr>
<td>5. Users classification</td>
<td>Equity is a priority; no users classes.</td>
</tr>
<tr>
<td>6. Price setting strategy</td>
<td>Prices set according to resource value and/or user willingness to pay</td>
</tr>
<tr>
<td>7. Payment</td>
<td>Either monetary or hybrid.</td>
</tr>
<tr>
<td>8. Quality of Service (QoS)</td>
<td>Guaranteed service, capped by estimated ATC sector capacity</td>
</tr>
</tbody>
</table>
Pricing Options for Scenario 2

Pricing Principle
- Marginal Cost pricing
  - Real time pricing
  - Flat pricing
- Second-best pricing
  - Consumption-proportional p.
- Ramsey pricing
- Peak-load pricing
- Auction-based
  - Bid pricing

Not functional for strategic demand management
Not functional for demand management.

Suitable if congestion-dependent.

Suitable issue: estimating customer elasticity
Suitable issue: guar. equity among users.

Issue: coordination (ultimate objective is system performance)
WHAT’S NEXT

- Evaluation of Scenario 3: competitive market among ANSP with service differentiation (i.e., user classification);
- Formulation of the models;
- Data filtering;
- Testing models on real traffic demand & airspace data;

Suggestions?

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