



An Agent-Based Model of Competition in ATM

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 Nommon Solutions & Technologies
 Brussels, 20th October 2017

Founding Members
 

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 JOINT UNDERTAKING

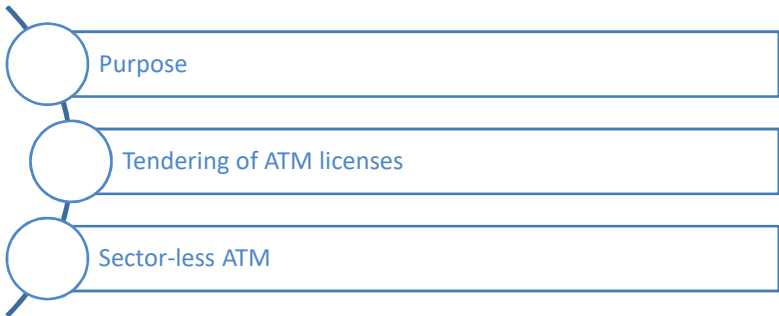


 **compair**
 Competition for Air Traffic Management

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Content



Purpose

Tendering of ATM licenses

Sector-less ATM

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Purpose

- The goal of COMPAIR is to study how to introduce competitive incentives in ATM so as to best contribute to achieving the European high-level policy objectives for aviation
- The purpose of this task is to simulate the potential impact of two different institutional designs to introduce competition in ATM:
 1. The tendering of licenses to operate en-route air traffic services in specific geographical areas (competition for the market + limited competition in the market)
 2. A hypothetical, more futuristic sector-less scenario in which ANSPs provide air navigation services to flights from origin to destination (competition in the market)

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Objectives



- Present the agent-based models
- Present the main results of the simulations
- Get your feedback:
 - Comments
 - Criticism/room for model improvement
 - Interpretation of results

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Tendering of licenses to operate ATS in specific geographical areas



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Overall description



The model simulates the tendering of licenses to operate en-route air traffic services in specific geographical areas and for a certain period of time

Three main elements:

- Geographical context
- Agents: Regulator, ANSPs and Airlines
- Exogenous variables: Passenger OD demand, fuel cost, technology evolution

Two stages:

1. Tendering process: ANSPs compete for the licenses to control different areas
2. Agents' evolution between auctions



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Assumptions and model constraints



- **ATCOs may monitor** not only flights in their current charging zone but also **flights in any of the charging areas controlled by the ANSP** they are working at.
- At the beginning of the simulation, **ATCOs working at a specific area ("legacy ATCOs") will maintain their labour agreement** throughout the simulation (until retirement).
- **Legacy ATCOs will work at the ANSP controlling their original area.**
- **New ATCOs**, who are hired throughout the simulation, **have the same cost for all the ANSPs** and will be employed by the same ANSP during all the simulation, unless they are dismissed.
- When **hiring/dismissing ATCOs**, there is an initial extra cost due to **the training/dismissal costs**.
- ATCOs have the same individual productivity. The **difference of productivity** between ANSPs is a **parameter of each ANSPs** (due to their level of technology adoption).
- **If the financial capital of an ANSP** during a certain period **becomes negative**, it goes into **bankruptcy** and disappears from the market in the subsequent tendering periods.
- The entrance of new players is not simulated.
- An **average plane size, occupancy rate and operational cost per kilometer** (excluding fuel and charges) are considered for all flights regardless of the origin-destination pair.

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Agents



Regulator

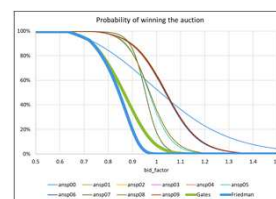
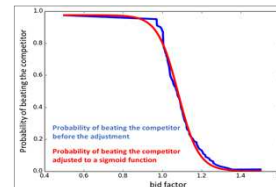
- Announce auction parameters, select winners, store data

ANSPs

- Objective: profit-maximisation
- Attributes:
 - Charging areas they control
 - Human resources
 - Financial capital
 - Bidding strategy/Learning method
 - Technology level

Airline

- Objective: meet the demand and minimise costs
- Attribute: Operating cost ASK



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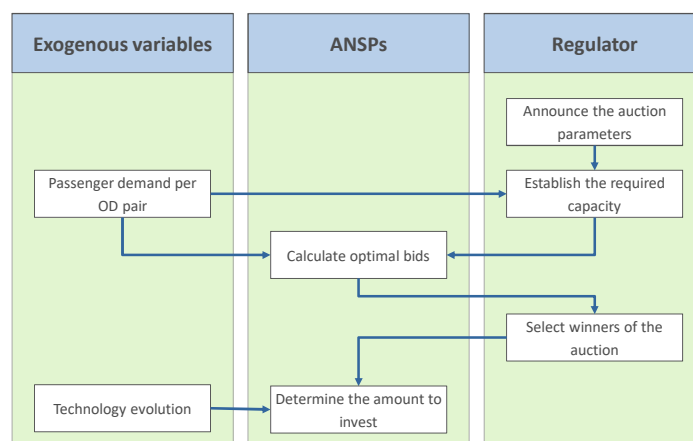
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Agents' interaction rules Tendering process



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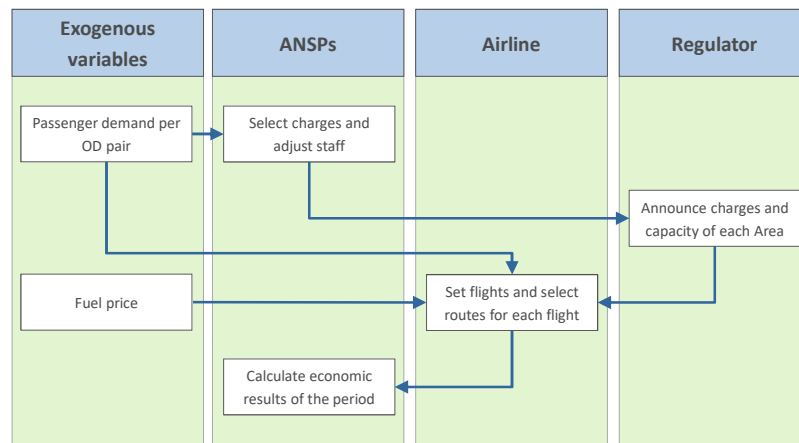
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Agents' interaction rules

Evolutive process



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Case study



Geographical context:

- 11 countries
- Set of routes for each OD pair

ANSP:

- 11 ANSPs (1 per country)
- ACE Benchmarking Report from 2014

Airline:

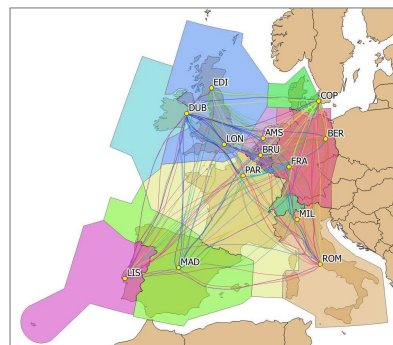
- CASK data (EJ, AF, LH, BA)

Temporal scope:

- 2050, in steps of 6 months

Demand forecast:

- Challenges of growth 2013 Task 7, "Regulated growth"



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Simulation scenarios



Analyse the outcome of different auction parameters

- **Maximum market share allowed:** 30%, 40%, 60%
- **Auctioning order:**
 - Ascending: From smallest area to biggest area
 - Descending: From biggest area to smallest area
 - Mixed order
- **Licenses duration:** 5, 10 years

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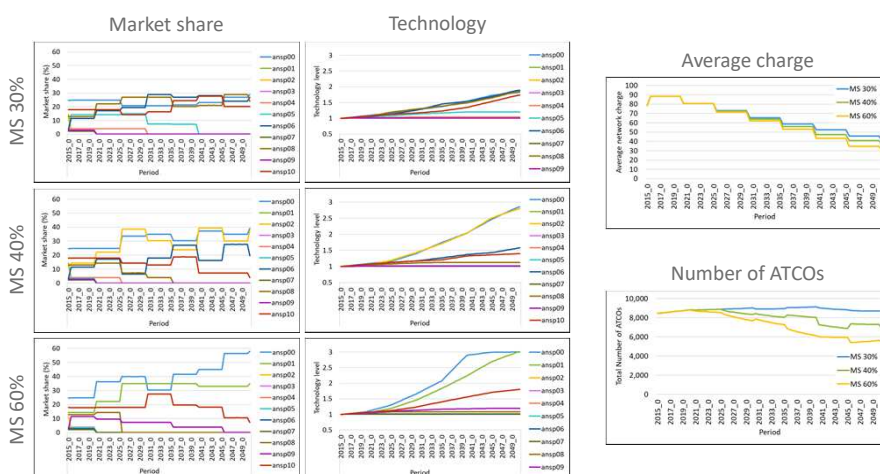
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Simulation scenarios Maximum market share allowed



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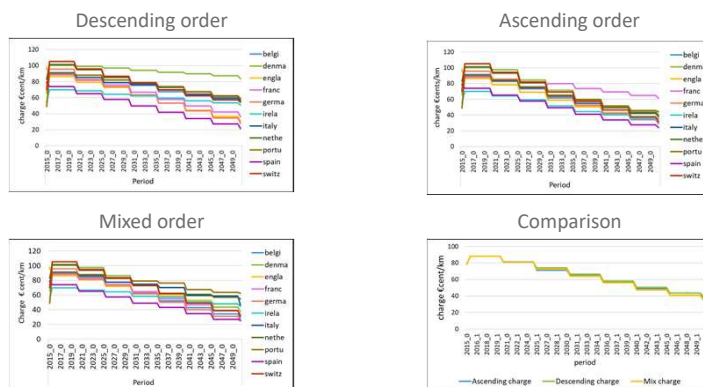
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Simulation scenarios Auctioning order



The auctioning order influences locally the charging prices resulting from the tendering but has a minor impact on the global outcome



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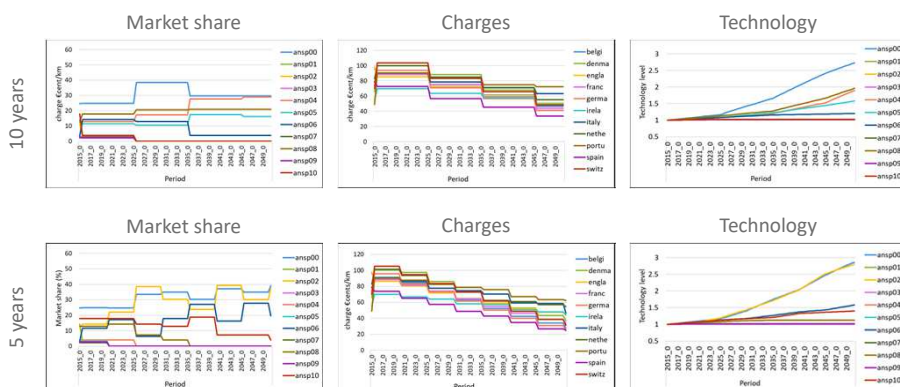
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Simulation scenarios Licenses duration



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Analysis of results Interactive tool



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Conclusions



- Competition leads to lower charges and smaller number of players.
- The ANSPs which control the biggest charging zones at the beginning of the simulation perform better in the long term thanks to economies of scale.
- When there is a dominant ANSP both the total number of ATCOs and the average charge are lower than in the case where the market is controlled by more ANSPs, but it could lead to an oligopoly in the long-term.
- The auctioning order has an important local effect on the tendering results, obtaining better bids for the countries that are auctioned first.

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Future research (in progress)



Additional simulations

- Simulate scenarios with different degrees of uncertainty in the exogenous variables
- Compare different auction designs: Sequential auctioning of different areas (learning process) vs Simultaneous auctioning of all areas in Europe

Additional model developments

- Model the possibility of new entrants
- Model different ANSPs and airlines strategies regarding investment in new technologies

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Provision of en-route air traffic services on a sector-less OD pair basis



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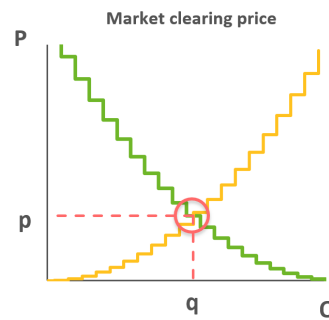
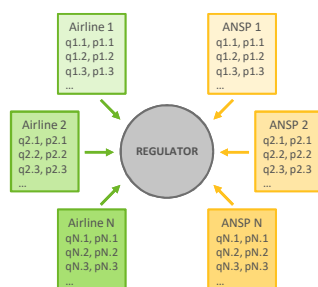
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Overall description



Simulate the provision of Air Traffic Services on a futuristic sector-less OD-pair

- Airlines ask for ANS (e.g. flight km). They can ask for different prices depending on the quantity of services (~ Customer)
- ANSPs offer ANS (e.g. flight km). They can offer ANS with different prices depending on the quantity of services (~ Electric company)



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Assumptions and model restrictions



- ATCOs may monitor any flight regardless the OD pair.
- The unit cost of monitoring a flight (€/km) is homogeneous across all the OD pairs.
- The variation of costs due to charges is transferred completely from the airline to passengers. So, the airline demand varies according to the demand elasticity of passengers.
- ATCOs will have the same cost regardless of their nationality and will be employed by the same ANSP during all the simulation, unless they are dismissed.
- When hiring/dismissing new ATCOs, there is an initial extra cost due to the training/dismissal costs.
- ATCOs have the same individual productivity regardless of their country, ANSP and experience. The difference of productivity between ANSPs is a parameter of each ANSPs (technology level).
- If the financial capital of an ANSP is negative, it is not allowed to participate in a new auctioning process, since it is supposed that the ANSP has gone into bankruptcy.
- The entrance of new players is not simulated.
- An average plane size, is considered for all flights regardless of the OD pair.

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Agents



Regulator

- Announce auction parameters, select winners, store data

ANSPs

- Objective: profit-maximisation
- Attributes:
 - Charging areas they control
 - Human resources
 - Financial capital
 - ~~Bidding strategy~~ (Bidding true-value is the dominant strategy)
 - Technology level

Airline

- Objective: meet the demand and minimise costs
- Attribute: Operating cost ASK

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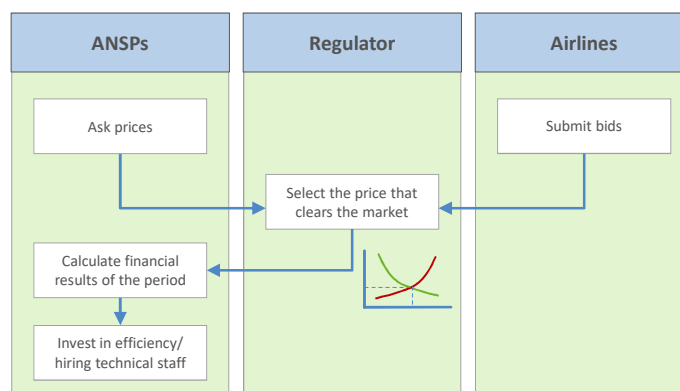
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Agents' interaction rules



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Scenarios and Research questions



Explore the impact of ANSPs' size and technology level:

- ANSPs with similar size and different technology level
- ANSPs with different size and similar technology level

Maximum market share allowed

Simulate scenarios with different degrees of uncertainty in the exogenous variables

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Questions?



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