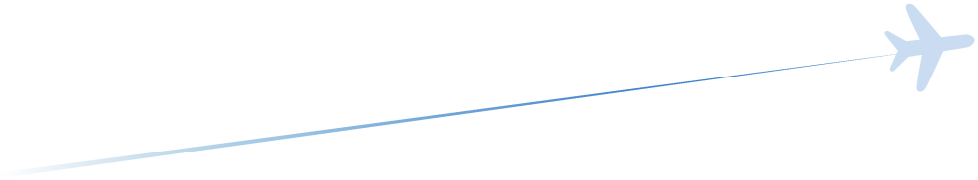


Workshop Report 2

Deliverable D6.4

COMPAIR

Grant:	**699249**
Call:	**H2020-SESAR-2015-1**
Topic:	**Sesar-05-2015 ATM Economics and Legal Change in ATM**
Consortium coordinator:	**Transport & Mobility Leuven**
Edition date:	**08 January 2018**
Edition:	**00.02.00**

Founding Members

EUROPEAN UNION EUROCONTROL

SESAR JOINT UNDERTAKING

Authoring & Approval

Authors of the document

Name/Beneficiary	Position/Title	Date
Andrej Kocsis/SLOT	Project Manager	08 November 2017
Eef Delhaye/TML	Coordinator	24 November 2017

Reviewers internal to the project

Name/Beneficiary	Position/Title	Date
Roland Guraly/SLOT	General Manager	24 November 2017
Griet De Ceuster/TML	Managing Director	4 December 2017
Rodric Frederix/TML	Senior Researcher	8 January 2018

Approved for submission to the SJU By — Representatives of beneficiaries involved in the project

Name/Beneficiary	Position/Title	Date
Rodric Frederix/TML	Senior Researcher	8 January 2018
Ricardo Herranz/Nommon	Senior researcher	4 December 2017
Nicole Adler / HUJI	Professor	4 December 2017
Roland Guraly/SLOT	General Manager	4 December 2017

Rejected By - Representatives of beneficiaries involved in the project

Name/Beneficiary	Position/Title	Date

Document History

Edition	Date	Status	Author	Justification
00.00.01.	12 November 2017	Initial draft version, submitted to partners for supplements and comments	Andrej Kocsis	
00.00.02.	24 November 2017	Draft version, supplemented by partners	Eef Delhaye	
00.01.00.	4 December 2017	Final version including comments received from all partners	Andrej Kocsis	
00.01.01	20 December 2017	New version taking into account comments SJU	Andrej Kocsis	Chapter 6 was added on lessons learnt, small typo mistakes solved, conclusion updated, names removed, participants list and list of acronyms added, references added
00.02.00	8 January 2018	New version taking into account comments SJU	Andrej Kocsis	Final version after second internal review

COMPAIR

COMPETITION FOR AIR TRAFFIC MANAGEMENT

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 699249.

Abstract

This report discusses the second public COMPAIR workshop held in Brussels on the 20th October 2017. The overall goal of the workshop was to present and discuss the models the COMPAIR project has developed. These models explore the possibility to include competitive elements into the Air Traffic Management. Within the workshop the models were discussed and feedback from the participants was requested with respect to applicability, possible hurdles and potential side effects. This report could also be read as the minutes of the workshop.

Founding Members
EUROPEAN UNION EUROCONTROL

Table of Contents

1 Summary

The overall goal of COMPAIR is to study various institutional and market design approaches for introducing competition for en-route Air Traffic Management (ATM) services, in order to assess their potential contribution to the European Single European Sky objectives.

The COMPAIR Consortium organised its second workshop in Brussels on the 20th October 2017. The primary objectives of the workshop were to

- Present and discuss the models the COMPAIR project has developed. The models study the effect of introducing different forms of competition into the Air Traffic Management.
- To receive feedbacks from the experts that attended;
- Assess whether the proposed institutional designs would lead to an increase of competitive forces into ATM;
- Assess the feasibility of the proposed designs; and
- Assess the possible side effects of such implementation.

The workshop itself was attended by the COMPAIR advisory board, experts from ANSPs, a regulator, Eurocontrol, universities, a representative of airlines and the project officers representing SESAR JU.

Each presentation was followed by a short discussion on the main results. Since the afternoon session had a panel discussion, most of the discussions took part in that session.

The presented models showed that the competition can be introduced into the ATM world and could potentially generate significant changes. However, from the discussions, it is becomes clear that such introduction should be carefully prepared. This preparation should cover the legal framework, technical requirements, safety requirements, etc. The introduced competitive environment should also be protected against monopolistic tendencies otherwise it could become contra productive –as experiences in other sectors have shown. It was further agreed that the long implementation period needed and rapid technological changes make it difficult to assess the outcome precisely.

This document summarises the workshop, the conclusions, and the next steps that the COMPAIR consortium decided to take.

1.1 Delivery objective

This deliverable describes the second workshop of the COMPAIR consortium. It includes

- The public presentations of the workshop
- Views of various stakeholders on potential pathways towards implementing the proposed changes
- Conclusions and next steps

1.2 Intended readership

This deliverable is public to provide information on the overall progress of the work. For the participants of the meeting and the people who planned to attend the meeting, they can also serve as minutes.

1.3 List of acronyms

Acronym	Definition
ABM	Agent-based modelling
ACC	Area Control Centre
ACR	Aviation Capacity Resources - private, international ANSP
ANSP	Air Navigation Service Provider
ATC	Air Traffic Control
ATCO	Air Traffic Controller
ATM	Air Traffic Management
CAA	Civil Aviation Authority
CASK	Cost per Available Seat-Kilometre
GIS	Geographic Information System
HUJI	The Hebrew University of Jerusalem
Nommon	Nommon Solutions and Technologies S.L.
OD	Origin-Destination
SESAR	Single European Sky ATM Research

TML	Transport & Mobility Leuven

1.2 Structure of the document

The document is organised as follows:

Chapter 1 introduces the document itself while Chapter 2 introduces the project and the role of the workshops within the COMPAIR project. Chapter 3 provides the background of the workshop, the work done by the project and the sources of the presented materials. Chapter 4 describes the participants of the workshop taking into consideration the privacy issues. Chapter 5 provides summary of the delivered presentations and some of the reactions. It also contains the opinions expressed during the panel discussion and the conclusions of the said discussion. Chapter 6 contains the more practical lessons learned during the organisation and conduction of the workshop. The conclusions on both the workshop organisation and the discussions are captured in Chapter 7.

1.4 Organisation of the workshop

The workshop was organised in Brussels at EUROCONTROL HQ (Rue de la Fusée, 96 1130 Bruxelles (Haren)) on 20 October 2017.

The organisation started well before the event by selecting the appropriate people and creating the list for invitation. Approximately 120 people of various background were invited.

In parallel with the sending out the invitations the website was updated with the necessary information and an application form was introduced. The invitation letter contained a brief introduction of the project, explanation of the workshop objective and a link to the website for further information. The form was sending automated confirmation to the applicants and a warning to the organisers about the new applicants. The applicants' details were saved into a database.

To achieve best results the invitation was followed by updates about the workshop such as by sending the preliminary and final Agenda.

The names of the participants were submitted to the EUROCONTROL HQ's reception desk for security purposes.

2 Introduction

2.1 The COMPAIR Project

The provision of air traffic management (ATM) services has for a long time been a national monopoly. In addition, it has traditionally been considered a natural monopoly due to the need for significant infrastructure investments. Both of these elements are now changing. Air traffic management has been under increased scrutiny of the European Union since the start of the Single European Sky program. Also, technological evolutions have reduced the need for large-scale ground-based infrastructure and expensive equipment, questioning the natural monopoly character of the industry. So it is the right moment to study the liberalisation and introduction of competition in the ATM sector.

Competition can be introduced at various levels and in different ways. The overall goal of COMPAIR is to study different institutional and market design approaches for introducing competition for en-route ATM services, in order to assess their potential contribution to the European Single European Sky objectives.

There are different ways to increase the overall efficiency of ATM. The current approach is more focused on centrally steered regulation. COMPAIR focusses on the introduction of competition as a trigger for change. However, competition does not exist abstractly, but is influenced by the legal and regulatory framework, and can be introduced at various levels and in different ways. At the start of the project we identified some concepts to be further analysed:

- A regulatory approach using yardstick competition.
- Auctioning approach using tenders to licence air navigation services within a certain charging zone.
- Unbundling of central infrastructure management tasks from service provision tasks.
- Sector-less based operations where trajectories are managed as origin-destination.

Within a **Deliverable 2.2**, we qualitatively analysed these options. The result can be found here: http://www.compair-project.eu/public-deliverables.html. The next stage consisted of analysing them quantitatively.

Within a **Deliverable 3.2**, (at the same link) following two questions were analysed:

- Can we link Air Navigation Service Provider (ANSP) performance and ownership? This was done by developing a small economic model and by estimating the production and costs functions for ANSPs.
- What is the potential for unbundling? This was illustrated by the example of the current practice of unbundling tower control.

Deliverable D4.1, (at the same link) focuses on whether it is possible to introduce competition *for* the market in air traffic control in Europe and the likely outcomes. We developed a two-stage, network, congestion game in which multiple air navigation service providers bid to serve Member State airspace. Airlines subsequently choose their optimal flight paths such that they minimize their operating costs. The individual Member States set up an auction in which they specify minimum service levels and the rules of the auction, such as the right to increase charges as a function of air service levels. The winners of the auctions are the service providers that bid the lowest charge. We test the likely equilibria outcome if the companies are for-profit or non-profit air navigation service providers.

Deliverable D4.2, (at the same link) is a study on two possible institutional designs for the introduction of competition in ATM. The first design consists in the tendering of licenses to operate en-route air navigation services in specific geographical areas for a certain period of time. The second scenario consists in the provision of air traffic services on a sector-less, Origin-Destination (OD) pair basis. These institutional designs are investigated by means of agent-based modelling and simulation, which allowed studying the resulting processes from a dynamical perspective.

2.2 Role of the COMPAIR workshops

The COMPAIR consortium planned to have two workshops in order to present its findings and to discuss them with the invited experts.

The first workshop was planned for month 12. At this stage of the project, it was useful to have the first validation and to establish that the work of the project is going in the right direction. This workshop took place in Madrid on the 7th of March 2017 and was summarized within D6.3 - Workshop report 1. Based on the analysis of the workshop, the concept and methodology used was validated.

The second workshop was planned near the end of the project. It was held at EUROCONTROL HQ on 20th October 2017 as a final validation check and communication of the main results obtained.

During the workshop, the Consortium had a thorough presentation of the project's findings and results for the models built. The invited stakeholders had the possibility of discussing the

presented models and the results of models after each presentation and during the panel session. The main emphasis was on the issues of implementation and the expected consequences.

3 Participants

The workshop was attended by representatives of regulatory bodies, ANSPs, airline representatives, universities, EUROCONTROL. As this is a public report, we will not present the individual names. The resulting discussion during the panel session was quite interesting and wide range of viewpoints was presented.

Table 1 Workshop participants[1]

Nbr.	Organisation	Nbr. of participants
1	Airline	1
2	ANSP	10
3	CAA	2
4	R&D	9
5	SJU	3
	Altogether:	**25**

[1] From total number of participants 7 people were from the consortium

4 Workshop details

4.1 Agenda of the workshop

The COMPAIR Consortium organised his second workshop in Brussels on the 20th October 2017.

The overall goal of the workshop was

- To present and discuss the models that the COMPAIR project has developed;
- To explore the possibility of including competitive elements into Air Traffic Management;
- To assess if the proposed models would achieve the desired results (improved efficiency, less fragmentation, take-up of technologies,…);
- To assess the feasibility and possible side effects of such implementation.

The invited experts represented most of the areas related to the ATM. It was important to have feedback how the envisaged changes would be seen from their perspective. The agenda was as follows:

Timing	Topic	Speaker
10:00-10:10	Welcome and status of the project	Eef Delhaye (TML)
10:10-10:40	The Air Navigation Service Provider's perspective	Arne Stokke (ACR)
10:40-11:05	Unbundling – Tower control	Stef Proost (TML)
11:05-11:25	Coffee break	
11:25-12:00	Economic modelling governance	Eef Delhaye (TML)

12:00-12:45	ATC: achieving the goals of the SES initiative	Nicole Adler (HUJI)
12:45-13:45	Lunch	
13:45-14:30	Introducing competition – Agent based modelling	Javier Torres (Nommon)
14:30-15:40	Panel discussion: implementation possibilities and next steps	Moderator: Stef Proost (TML) Panel: Florent Beron, Arne Stokke, Eva Szentgyörgyvölgyi, Paula Leal de Matos
15:40-16:00	Overall discussion and lessons learned	Eef Delhaye (TML)

4.2 Workshop presentations

All presentations can be found in ANNEX 1: Presentations.

4.2.1 Welcome and introducing the COMPAIR project

Dr Eef Delhaye has welcomed the participants and briefly introduced the COMPAIR Project at the beginning of the workshop.

4.2.2 The Air Navigation Service Provider's perspective

Mr. Arne Stokke is founder of the Aviation Capacity Resources (ACR). This private, international ANSP was established in 2004 and entered the market in 2011. The competitive market in Sweden consists of 21 airports. ACR operates air traffic at two of three Swedish airports and for 14 towers. In addition to air navigation services, ACR delivers expertise and consulting services, nationally and internationally.

The presentation contained a snapshot of the ANSP industry and discussed their own cost performance compared to more traditional ANSPs. It was pointed out that ATCO costs are not the problem; the support costs are.

After the presentation, the following points were discussed:

- ACR providing services reduced costs overall. Due to their entry, the other market players were also forced to cut the costs. Today about 5% of the market is under competition, 95% is still a monopoly.
- There have been some predatory responses. Tenders had to be stopped when the case was brought before civil court. It is a complex process and it takes extremely long to set it up.
- Competition is technically feasible in all countries. All ANSPs use in se the same technology; it has to be compatible and safe.
- ATM is not a natural monopoly per se. A distinction has to be made between operational environments: en-route, approach/departure, aerodrome control service. With respect to tower control there is no upper limit in size for tendering. ACR operates in airports ranging from 50.000-500.000 passengers.
- There is however a need for a regulated market. It works in Spain, Sweden, Norway,… In addition airports report increased customer focus, innovation and price transparency due to the tendering process.
- Competition does not need to impact safety. Safety remains the number one priority and is heavily regulated and followed up.

4.2.3 COMPAIR - Unbundling

Professor Stef Proost presents the topic of unbundling from a more theoretical approach

- What are the main benefits of a market for tower control?
- What has been the experience up to now?
- What are the conditions for a market to develop?
- What are the different interactions? This is shown by using a game tree.

The primary focus of this work on unbundling is tower control. Competition for tower control only exists in a few countries. However, it could be considered as a main area of introduction of competition in ATM sector. Other areas in air navigation system provision (for example Meteo, Communication, Navigation and Surveillance) can also be outsourced, but this is different because it is no longer the airports who decide but the ANSP itself.

No comments are made on this presentation.

4.2.4 COMPAIR: Economic Modelling - the influence of ownership

The following presentation was delivered by Dr Eef Delhaye. The focus of this presentation lied on “governance” and “ownership”. From this modelling, the project expects positive effects of privatisation with stakeholders as shareholders or the inclusion of a board of stakeholders in a non-for profit organisation. Eef also discussed the econometric estimates for the cost and production function to assess the influence of governance on performance.

The audience expressed the following remarks on the presentation:

- An important point is that the commercial pressure delivers the efficiency. Do you necessary need to sell the assets to shareholders? Where does the pressure come from? The big efficiency gains in steel industry came before they sold the assets. When the government stepped away (UK) it led to poor performance. Hence, probably governance is more important than ownership.
- The effect might be different in different countries.
- In sectors such as ATM it is important to have the users in the governance role (such as in NavCanada). The most important service is safety in a cost efficient manner.
- A study was performed with the same questions on factors explaining performance. Governance was more important than ownership. You internalize in the board the pressure you have between users and providers. With an economic regulator you don’t have this communication. The regulator does not know what the provider can

do. Hence, it would be better if the analysis could look deeper into the type of governance. Unfortunately this information is not easily available.

4.2.5 Air Traffic Control: achieving the goals of the Single European Skies initiative

Professor Nicole Adler presents the result of tendering the right for en-route services using a game-theoretical model. In this work, air traffic control is modelled via a 2-stage game, which enables a cost-benefit analysis including distributional effects across stakeholders. A case study for Western-Europe has also been developed.

The audience expressed the following remark to the presentation:

- The value of these exercises is in the insights it produces. We can perhaps omit economic regulation. Government structure remains however an important issue.

- In other utility industries they are moving away of the profit model (rail, water) while these results favour competition between for-profit forms. There can be a good form of governance. Competition is seen as an answer, but privatisation in the UK was done with the aim to get away with regulation. 30 years later, economic regulation is still there. So yes, you can introduce competition but there should be substantive, sufficient competition. Maybe some of these problems can be solved by giving licenses for only 4-5 years. There is also the added benefit that you no longer need price caps.

- Is it not a problem that you end up with few ANSPs? A provider that does that for 5 years would have an unfair advantage to other bidders. How to deal with this in a second tender? There should be shared information and the market would need to be transparent. There is airspace specific complexity and seasonality but airspaces exist everywhere.

- There will be only a couple of providers left, since they have more experience and advantages. After 10 years it is unlikely that new players come into the market. This might be overcome from competition within. People not satisfied with their ANSP could start a new company taking their knowledge with them. In any case there should be at least four companies in the market.

- Is it possible to separate which effect causes the largest decrease in costs? The tendering or the difference in ownership. Yes -we ran the models with and without the tender.

4.2.6 An Agent-Based Model of Competition in ATM

Javier Torres presents the results of the agent-based modelling of two scenarios

- Tendering the licenses to operate en-route airspace
- Tendering of O-D routes (sector-less ATM) Feedback from the audience

The audience expressed the following remark to the presentation:

- Typically airlines fix their schedules for a season, capacity costs are fixed. Does this make a difference?

- We only play with the cost variable, not with fares (cost minimisation in terms of route choice).

4.2.7 COMPAIR Panel discussion

Professor Stef Proost guided the discussing by presenting the following questions.

In your opinion how likely is it that by 2030 the European Air Traffic System will be managed in a competitive environment?

(Do you expect full competition in the field of tower control?)

- There is difference in attitude in different countries. Countries want to control their own airspace and changing this attitude is something you have to solve first.
- Yes, there might be some competition, but seeing the slow development of the ATM in general, it is not sure that we will have a high level of competition. From the ANSP point of view, we actually have a kind of competitive cooperation. However, the competition is not about the market, rather about the influence that one could have on the future. Today, the driving force behind innovation is not the competition itself rather the feeling that eventually it will be introduced and the ANSPs should be prepared for that. ANSPs also try to find new possibilities like in case of the drone question which opens up a new market. We could say that ANSPs compete already; at the same time, due to the nature of the ATM system, they also should cooperate.
- Competition is already present at the system, but not because of economics, but because of the implementation of new technologies.
- Due to new technologies, ANSPs will not be any more air traffic managers, but rather airspace managers. This will result in a new kind of competition.
- I don't think that competition will be introduced by 2030 as I see a trend now that the countries are more aware of their national interest. This will slow down the process of relinquishing of the national monopoly on the airspace. On the other

hand, the new technologies will completely change the market and the rules of the game. Then again, there is no political will to have the competition.

- With all this technology on board of the aircraft, allowing for self-separation, there is a parallel with what happened to the travel agents, which are disappearing due to technology. It is possible that something similar could happen to today's ANSPs. I also share the concern about the political situation; the countries are more inward looking these days than before. The appetite for the region wide international infrastructure strategies is diminished. The Brexit also poses a challenge in the competition. The game theory is a nice tool to look at the fact of why we haven't seen any progress in SES initiative.
- It looks to me that the situation is like in the era of the stagecoaches, when they were struggling to improve the stagecoaches not realising that the cars were coming. On a recent meeting, people from Amazon and Airbus and others were saying that there is no need to deal with ATC as they will sort it out. When there will be hundred times more drones flying than today, the separation will be only one percent of the problem, which we will solve for you anyway. Maybe it is extreme to put it this way, but it is certain that considerable change is coming. One reason for that is the drones are coming and the other one is that the aircraft will be able to separate themselves. Also, there will be new concepts coming from SESAR which would allow the aircraft to separate itself against the rest. Once you do this you no longer have the natural monopoly. Therefore, it may be that the situation in which we operate will change completely.
- The reasons for ANSPs to invest in technologies are that, on the one hand, there are regulations, there is SES and SESAR plus there are incentives and funds from the EU. On the other hand, with the centralised services there are new services and functions which lead to the situation when fewer players will be involved. Some ANSPs may feel that not being in the loop, not following the developments and not being involved with SESAR would cost them the influence they may have or may not have on the future situation. This is another strong incentive for investing into the new technologies for ANSPs.

What kind of competitive scenarios do you think are the most likely to be adopted and why?

- The en-route sector is not the cash cow for the ANSPs. ANSPs earn a lot of money from terminal and the airports. Therefore, it is difficult for the states to open the market for the tower control and the terminals.
- Providing the service for Kosovo from Hungary was also a political decision. It wasn't the decision made by Kosovo to open the market. Usually the bottom up approach doesn't work in this case and the decision to open a market probably will have to come from the EU. The UK has its traditional competition, but the rest of the Europe may not have it. The other states would keep the current approach until the EU will provide a strong argument for introducing the competition and it may become mandatory for all member states. Once the opening of the market is mandatory, the

unbundling will have the biggest potential. There are already some initiatives in the supporting activities towards opening for the market, but not in the core business.

- This will not come at once. One way to look at it is where the pressure can change. For the moment, with Single Sky performance targets, the ANSPs have strong incentives to reduce their costs. I would expect that ANSPs would get together and pool some of their support costs. This is not happening for some reasons. Even with the SESAR deployment we see as many silo projects as there can be, but there is not one view which says 'provide me with a standard that everyone can use'. In ATC you have to know where the aircraft is, so it is the SWIM and where they will be and that is the flight plan. These are the very basics and all the ATCs make sure to keep this information in-house. Except for the information saying that this aircraft will cross the boundary at this place at this time. In the US if traffic should be rerouted due to the weather, it is propagated for the whole of the US. If it is rerouted - say for whole of the Switzerland- this information is not shared. It seems to be done this way to make sure that nobody can have the whole picture. The cases like Hungarocontrol providing services in Kosovo or Maastricht providing radar and flight plan services for Slovenia show that it is possible not to invest in infrastructure, but to buy the service. I would expect some form of unbundling when some providers would provide the SWIM services about where the aircraft is and where it will be and allow communication between ATC services. This unbundling of basic information is expected to come from SESAR. The costs will be completely flat and you will manage to squeeze in more traffic at the same costs.
- In some cases competition is the way to go. For example in the case of British Airways when the government said they have failed to make it efficient and privatised the airline. After this it became really efficient and it was the competition that drove that.
- In the US there is two third of ATCOs and one third of support staff and in Europe it is the opposite. In ACR there are 90% of ATCOs and only 10% of the support staff. This may be an extreme case, but it indicates that there is room for consolidation.
- We see airlines joining alliances even if they compete fiercely with each other and we don't really see that in case of the ANSPs.

To what extent could the current Tower Control competition be used as a benchmark for en-route privatization?

- The example of the Gatwick airport is a bit confusing as the private daughter company of DFS - a public company -does it.

Our models show that there are potential benefits of introducing competition by changing ownership form and/or auctioning airspace. Privatization is also being discussed currently in the US. What would be the main hurdles towards implementation of these concepts? Do you see any way to overcome the hurdles that you identified?

- Change of ownership on its own will not do anything in this regard. The example of NATS shows that although it is incredibly cost efficient, it is very expensive to the consumers in term of prices. They have airlines among the owners and although they paying their fees to NATS while operating, they receive part of it back from NATS as shareholder to the expense of other airlines who are not shareholders. Ownership form won't guarantee for the airlines that anything will change.
- The private airport is more interested to open the market for tower control than the public.
- In some countries the airport has nothing to do with the ATC. The ATC charges directly the airlines.
- There are two approaches to the question. Either the infrastructure is owned by the government or airport and only the management of the air traffic is done by a privatised company or the private company has to maintain the infrastructure as well. Therefore, if it's to go to another market it has to invest into additional infrastructure as well.
- Providing services remotely does not require a huge investment. Even if we consider much larger airspaces it is manageable and the new technology available allows having all the necessary information to manage the air traffic at any given airspace.

We have used the notion of sector-less ATC provision as an enabler for introducing competition. It could also lead to more concentration. Do you think that technological developments will increase or decrease the level of competition?

- In case of tower control, you have a clear example where the state or the airport has the necessary infrastructure and private company can enter the competition to manage it. This creates a levelled field for anyone to enter the competition. The problem with new technologies is that it could introduce some barriers to entering the competition, as it would require a considerable investment. This would provide a certain advantage to the big ANSPs. In the case of SESAR you can see that the big ones already possess the advanced technology and therefore they have a better position from the start. It would be important to level the play field in this case too.
- You're talking about the competition for the market when the authorities allow different companies to compete for the market. In sector-less case you have a competition in the market as to fly over for example France you don't have to use French ANSP anymore. Therefore, the natural monopoly isn't there anymore. If several ANSPs would be licenced to provide services from entering European airspace to the end then there no longer be that natural monopoly. For sure, this won't be available for the near future, but it is possible.
- The sector-less ATC will give space for many new business models and new ways of running the business.
- The sector-less ATC and the new technology means that you can separate yourself most of the times, however it doesn't mean that you don't need ATC as in cases of dense traffic self-separation could become problematic and then you will require help from the ATC. The shift from self-separation to the ATC controlled traffic should

be seamless and the barrier between them probably will be moving with the level of available technology.
- The airlines would decide which provider they would select.
- The sector-less operations would probably start at one state and once the concept is proven the airlines will pressure the governments to accept the new way of operation if they have benefits from that.
- The workload will be more predictable than today as now we have 20 percent of sectors with 40 percent of traffic load. The system now is to some extent empty and generates unused capacity, which makes the current system inefficient. In some areas, the current system is crowded and this generates delays. This is because you cannot transfer the capacity from one sector to another. In the sector-less ATC it is clear that there is an aircraft to control, so the necessary resources should be provided.

What kind of impact could non-traditional aircraft (e.g. drones, semi and remotely and automatically-piloted vehicles) and their operators have on the current ATM market both from a technological and financial perspective?

- We have to think completely different as drones will manage themselves. The ATC will manage the airspace. The ANSPs will be more like data aggregators. The drones will have lots of equipment on board; they will know where the obstacles are and where the other users are. Still they would require information on the airspace and the conditions they operate in. The ANSPs and ATC will not separate anymore; they will manage the airspace. However, until that point the ANSPs will increase their efficiency. If we look at the time frame it may be that the competition concerns the ATC rather the airspace management. Maybe new parties will be involved into competition. Instead of DFS and Skyguide there will be Google and Amazon.
- Data aggregators would mean that the ANSPs generate radar data and obstacle related data. The risk won't be the colliding in the air rather the risk will be for those on the ground. So you maybe have to build you entire concept not based on the risk in the air, rather based on the risk on the ground.

4.2.8 Conclusions of the discussion

During this workshop an example of tendering tower control showed that it is possible to achieve cost reductions even at a very low rate of competition by the entry of private companies in the management of the traffic.

This was also reflected in the research findings which emphasised

- The role of governance/ownership.
- The potential of unbundling, which is clear in the case of tower control, but might be less easy for other services controlled by the ANSPs themselves.

- The potential in cost reduction and increased uptake in technologies from tendering out licenses for en-route control (per country or per OD).

From the discussions, we learned that

- Unbundling has the most potential for the near future. In some countries competition is already in place for tower services and in some cases the competition could happen also for core services.
- One of the most important hurdles is the political level and, more specifically, the question of sovereignty. On the other hand, this should not be a hurdle as during the tendering the state defines the rules and the conditions.
- Feasibility will hence also greatly depend on the country. Some countries will be more open for this type of changes than others will. This also means that probably EU action will be needed.
- The role of technology can go both ways. Our findings show that competition is required to speed up the uptake of new technologies. But we also heard that this could be the other way around. Technology could be an enabler of more competition within ATC. It might even be the case that by 2050 there will be no need any more for air traffic control, but only for airspace management.
- New technologies (e.g. drones) might bring opportunities to change the market/rule of the game. The question is if new technologies might not arise quicker if there is a more competitive market. On the other hand, investment in technologies could also block competition if they are only feasible for the larger ANSPs.
- Another point raised was the question if privatisation is needed. Probably governance is more important.
- The question of who owns the infrastructure needs to be solved before one can tender. This will also be different in different countries.

These findings will be used within the concluding work package. In this work package, we will develop a view on how the most desirable institutional frameworks could be realized. For this, we investigate the feasibility of the options proposed and analyse the acceptability of the proposed changes for various stakeholders. This workshop was part of the stakeholder consultation.

5 Lessons learnt from the workshop

The objectives for organising this second workshop were clear from the beginning. The overall goal of this workshop was to present and discuss the models the COMPAIR project has developed to explore the possibility of introducing competition into the Air Traffic Management. It was important for the consortium to assess if these proposed models would achieve the desired results (increased efficiency through the introduction of elements of competition) and assess the possible side effects of such implementation.

Hence, the focus of this workshop was to discuss the models and the impact they might have upon implementation. In order to achieve this result, it was very important to have

- An example with real life experience – although at a smaller scale – to show that the theoretic ideas are feasible
- A group representing a different viewpoints and from different backgrounds
- A group large enough to have a discussion, but not too large such that everyone has the opportunity to speak.

The workshop was organised with these objectives in mind.

From the organisation of the workshop, the following lessons can be learned.

- It is always good to have some outsiders with real life examples to set the scene
- The selection of the experts invited should be broad to generate good discussion and to have as many viewpoints as possible
- The invitations should be made well in advance as the best experts are usually busy all the time and they run out of free slots for workshops very fast.
- It is better to invite two persons with the same area of expertise as one of them might cancel the participation in the last minute.
- Always have a backup plan (another expert to be invited)
- Initially we have expected that the total number of participants would be around 20 to 30 persons and for that to achieve we have send out the invitation to more 120 people. 18 people accepted the invitation.
- The invitation should be sent out well ahead; however, some peoples could forget, therefore it is good to send some remainders periodically offering some additional information like new deliverable related to the topic of the workshop to keep the communication alive or rise the interest of those who initially would not participate.

- The selection of the workshop location is a key factor. Brussels is well visited and the invited experts could have other obligations before or after the workshop, so they might consider to participate on the workshop as part of the prolonged stay in the city and not as another journey. The EUROCONTROL HQ is a well-known location and suitable for workshops like this. Important experts for the purpose of this workshop were located in the vicinity of the workshop location, so it was a bit easier to convince them to participate despite of their busy schedule.
- The timing of the workshop was adequate, however, in the last couple of years it seems that the timing is never good and the most one can do is to avoid the workshop organisation in the summer and Christmas period.
- Round tables limit the number of participants but ease the discussion.
- If the participants have direct involvement in the topic and the appropriate knowledge the resulting discussion provides good and substantial results.
- Panel is a good instrument to boost involvement of non-consortium members and to make people listen.

Although the number of the participants was a bit less than expected, most areas of the aviation[2] were represented and we achieved a friendly mood that led to a good discussion.

[2] Airports were not represented

6 Conclusions

The workshop was organised at EUROCONTROL HQ (Rue de la Fusée, 96 1130 Bruxelles (Haren)) on the 20th October 2017. The location and timing proved to be good as there were 25 participants from various organisations like SESAR JU, EUROCONTROL, IATA, ANSPs and CAAs representing most of the stakeholders in aviation. The mood was friendly allowing for good and lively discussion.

Since the participants were of different background and the topic of the workshop was somewhat complex one would expect less involvement from the participants, however, the discussion went well and the participants showed deep interest and knowledge of the topic providing substantial arguments.

During this workshop an example of tendering tower control showed that it is possible to achieve cost reductions even at a very low rate of competition by the entry of private companies in the management of the traffic.

This was also reflected in the research findings which emphasised

- The role of governance/ownership.
- The potential of unbundling, which is clear in the case of tower control, but might be less easy for other services controlled by the ANSPs themselves.
- The potential in cost reduction and increased uptake in technologies from tendering out licenses for en-route control (per country or per OD).

From the discussions, we learned that

- Unbundling has the most potential for the near future. In some countries, competition is already in place for tower services and in some cases, the competition could happen also for core services.
- One of the most important hurdles is the political level and, more specifically, the question of sovereignty. On the other hand, this should not be a hurdle as during the tendering the state defines the rules and the conditions.

- Feasibility will hence also greatly depend on the country. Some countries will be more open for this type of changes than others. This also means that probably EU action will be needed.

- The role of technology can go both ways. Our findings show that competition is required to speed up the uptake of new technologies. However, we also heard that this could be the other way around. Technology could be an enabler of more competition within ATC. It might even be the case that by 2050 there will be no need anymore for air traffic control, but only for airspace management.

- New technologies (e.g. drones) might bring opportunities to change the market/rule of the game. The question is if new technologies might not arise quicker if there is a more competitive market. On the other hand, investment in technologies could also block competition if they are only feasible for the larger ANSPs.

- Another point raised was the question if privatisation is needed. Probably governance is more important.

- The question of who owns the infrastructure needs to be solved before one can tender. This will also be different in different countries.

These findings will be used within the concluding work package. In this work package, we will develop a view on how the most desirable institutional frameworks could be realized. For this, we investigate the feasibility of the options proposed and analyse the acceptability of the proposed changes for various stakeholders. This workshop was part of the stakeholder consultation.

The conclusions on the workshop organisation are the followings:

- We were reinsured that it is always good to have experts from different stakeholder groups to initiate debates and good discussions
- If the participants have direct involvement in the topic and the appropriate knowledge the resulting discussion provides good and substantial results
- Panel is a good instrument to boost involvement of non-consortium members and to make people listen
- Even involved topics can generate good discussions if the audience is really interested in the work done in the project
- For future events, the date should be announced earlier to enable all key invitees to attend.

From the project's point of view the workshop can be considered as successful as it generated a good and detailed discussion related to the project's topic and the expressed viewpoints adding to the project's findings although also generating some new questions that might need some further investigations.

7 References

The goal of the workshop was to present the work done by the consortium and to generate a discussion on that. For that reason, the source of the presented material is the deliverables created by the project members:

Adler, N. et al., D4.3 COMPAIR report - Public report summarizing the main insights and policy recommendations that can be drawn from the quantitative impact assessment, COMPAIR project Deliverable 4.3, December 2017 (public)

Adler, N. et alD4.1, Report on Introducing Competition in European Air Traffic Control Provision using Game Theoretic Principles, COMPAIR project deliverable D4.1, December 2017 (Public) research report on the network game theoretic model

COMPAIR Grant Agreement 699249

COMPAIR Grant Agreement Part A

COMPAIR Grant Agreement Part B

Delhaye, E. & T. Blondiau, D2.2 Public Report on outlining various institutional design options, COMPAIR project deliverable 2.2, January 2017 for liberalization of ATM services in Europe (public)

Delhaye, E. et al D3.2 Public Report on outlining results of the economic analysis, COMPAIR project deliverable 3.2, May 2017 (public)

Delhaye, E. et. al. COMPAIR Project Management Plan, COMPAIR project deliverable 1.1, September 2016

Herranz, R. et al. D2.1 Internal report describing the assessment framework for evaluating institutional options, COMPAIR project deliverable 2.1, August 2016

Litwick, A. & Adler, N. D3.1Development of Common Modelling Guidelines, COMPAIR project deliverable 3.1, January 2017 Internal report containing guidelines on common assumptions, data inputs and output indicators for various models and scenarios (internal)

Torres, J., D4.2 Public research Report on the agent-based auction model, COMPAIR project deliverable D4.2, November 2017 (public)

Vass, P. et al, D6.3 Workshop Report 1, COMPAIR Deliverable 6.3, April 2017 (public)

Founding Members
EUROPEAN UNION EUROCONTROL

ANNEX 1: Presentations

1. Welcome and introducing the COMPAIR project

compair
Competition for Air Traffic Management

TRANSPORT & MOBILITY LEUVEN NOMMON האוניברסיטה העברית בירושלים THE HEBREW UNIVERSITY OF JERUSALEM Sioen Consulting

compair

COMPAIR 3

Introducing COMPAIR

Background

- Air transport is facing many challenges (growing demand, larger airports, increased network congestion, disruptions,…)
- Air Traffic Management is an important player
- The Single European Sky has set ambitious targets for ATM (capacity x3; costs:2)
- However, progress towards targets is perceived as slow
- SESAR WP-E project ACCHANGE: problem of incentives, fragmented market, home-bias

- COMPAIR:
  - would competition be the solution?
  - And if so – how do we introduce competition?
  - Research question: how to introduce competitive incentives in ATM?

compair

COMPAIR 4

4 options which might make sense?

- Regulatory approach/governance
  - Idea of increased involvement of ATM customers ->higher customer focus
- Unbundling of support services (tower control, MET,…)
  - Competition IN the market
- Tendering of En-Route ATM (temporary licenses)
  - Competition FOR the market
- Sector-less ATM
  - Competition between ANSPs (for OD routes/network of airlines)

Satellite technology is making radars largely obsolete. Modern aircraft mean that, as was the case with telephones, the intelligence is rapidly moving from the centre to the edge. Less need for ground-based infrastructure provides the potential for multiple air navigation service providers to compete with each other in the same airspace, as well as across borders. Competition for the provision of air traffic management services would bring a number of benefits including a more customer-focused service, more efficient air traffic service provision (and therefore lower fares for passengers), innovation and faster adoption of new technologies.

https://www.internationalairportreview.com/news/36342/privatisation-faa-atm/

compair

COMPAIR 5

Founding Members
EUROPEAN UNION EUROCONTROL

Methodology

4-step approach

1. Qualitative exploration of alternative options
   - Desk research, literature, feedback ATM experts (survey, AB, interviews)
   - Result: D2.2: Qualitative exploration of alternative options
     - Trade-off between effectiveness and implementation feasibility
     - Unbundling was seen as most promising
     - Tendering possible but political and social barriers
2. A first quantitative assessment: economic analysis
   - IO models, game theory, econometric estimations
   - Simple models
3. A more comprehensive quantitative assessment
   - Game-theoretic network model
   - Agent-based auctioning model

Goal of the workshop

4. Feasibility?
   - Towards implementation

COMPAIR 6

Not to forget

A big thank you to Eurocontrol for hosting us!
A big thank you to all to come and listen to us.
We value your comments and questions.

Practicalities

- Pictures are taken during the workshop – we assume your permission, otherwise please let us know.
- We will be recording – but we will never use individual statements (anonymous)
- Please do not forget to sign our list of participants.
- When you leave, please return name tags.
- Presentations will be provided.

COMPAIR 7

Welcome and introducing the COMPAIR project

Thank you very much for your attention!

This project has received funding from the SESAR Joint Undertaking under the European Union's Horizon 2020 research and innovation programme under grant agreement No 699249

Founding Members

2. The Air Navigation Service Provider's perspective

ANS market in Europe before RP 3: snapshot of an industry

- The 2015 analysis of cost-effectiveness of European ANSP (ACE) shows that ATM/CNS provision costs (per ANS hour) reduced by 1.2%
- However: Main reason is that the traffic growth outpaced the growth of costs
- Overall unit cost (cost for composite flight hour) increased by 3.2%
- 25 out of 37 ANSP saw increase in ATM/CNS costs (although 22/25 experienced traffic increase)
- In total ANS/CNS costs in Europe of 8.124 Billion EURO
- Until 2019 it is expected that average European ATM /CNS unit costs raise with 1.7% - per year

SES in Europe before RP 3: snapshot of an industry

- 69% support costs are the main cost element for ANSP and consist of: Costs of non-ATCO in OPS employment, non staff operating costs, capital related costs, cost of capital, Project Costs, R&D, etc.
- ATCO employment costs per ATCO hour is **EUR 112**
- While unit support costs (per unit/hour output) is **EUR 292**
- On average 2.2 additional staff employed for every ATCO in Europe
- ATCO number percentage of total staff in Europe typically between 25-30% with a strong variability between smaller organizations (Finavia 54%, Cyprus 47%)
- And larger and/or more bureaucratic organizations (DHMI (Turkey) 19%, LPS (Slovakia) 17%, UkStase (Ukraine) 18%)
- Results in a ratio of total of 17600 ATCO in Europe to a workforce of 39000 staff (supporting & enhancing ATCO productivity)

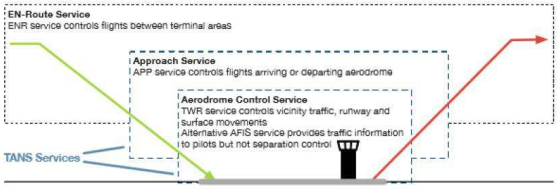
Is ATM industry a Natural Monopoly?

Properties of Natural monopolies :

- If a single firm can serve that market at lower cost than any other or combination of two or more firms
- Can arise as a result of very high fixed costs or start-up costs of operating a business in a specific industry
- Can be found in industries that require unique raw materials, technology or other similar factors
- Arise where the largest supplier in an industry, often the first supplier in a market, has an overwhelming cost advantage over other actual or potential competitors (as scale economies can be achieved)
- A natural monopoly occurs when the most efficient number of firms in the industry is one

Is that true for ATM?

ATM Industry and the different operational environments



- In ATM, a distinction must be made between the operational environments: En-Route, Approach (Departure), Aerodrome Control Service
- En Route with higher operational complexity and relatively high fixed costs and sovereignty issues
- Approach / Aerodrome Service (TANS) a ‚natural' candidate for competition: low complexity, low investment thresholds,
- Segment of smaller /midsized airports outside the performance regulation

TANS as a part of the European ANS system

- SES regulations (Performance scheme, charging regulation, etc.) focus primarily on the overall network performance and 'simulate' market conditions
- TANS function crucial in connecting the airport level with the Network
- Of the 700 European airports , 42.5% are loss making….but
- 75% of European airports below 1M PAX go in that category
- 93% of all airports worldwide are below 1M Pax
- Net Profit Margin at these airports is on average -6%
- ANS Provision Costs for smaller Airports proportionally higher than for larger airports: typically in the range between 20%-50%
- Airport Operators forced to procure ANS from monopoly: no influence on service levels, cost, type of service
- If ANS cots considered 'inelastic', cost reduction for airports can only be achieved through:
  - Reduced Opening Hours
  - Reduction in Service

TANS competition requires a deregulated market

- Deregulation is the reduction or elimination of government power in a particular industry, usually enacted to create more competition within the industry.
- The underlying motivation & rationale for deregulation is that fewer and simpler regulations will lead to a raised level of competitiveness, therefore higher productivity, more efficiency and lower prices overall.
- Within ATM, deregulation is aimed at un-locking the ATM market for the open offering of ANS (ATC /AFIS) and support services and the
- Prevention of market monopolies unwilling (or unable) to improve cost-efficiency and service quality (customer focus)
- Safety Regulations are all remaining in place
- SES regulatory framework setting the fundament for a 'level playing field'
- National SES certification process as tool to assure full compliance with the regulatory framework

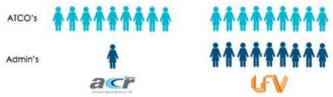
TANS in a competitive market : does it work?

Country	Service	Cost Savings
Spain	TANS	46.7%
USA	TWR service at 253 VFR Airports	74%
Sweden	TANS	30-40%
Norway	TANS	35%

- Cost efficiency main benefit as result from increased competition in the market
- Data on UK and Germany not available but estimated to be in the range of between 30 % and 40%
- In addition, airports report increased customer focus, innovation and price transparency as result of competitive process
- Results in line with experiences from other deregulated industries

Effects of Competition on the ATM Market

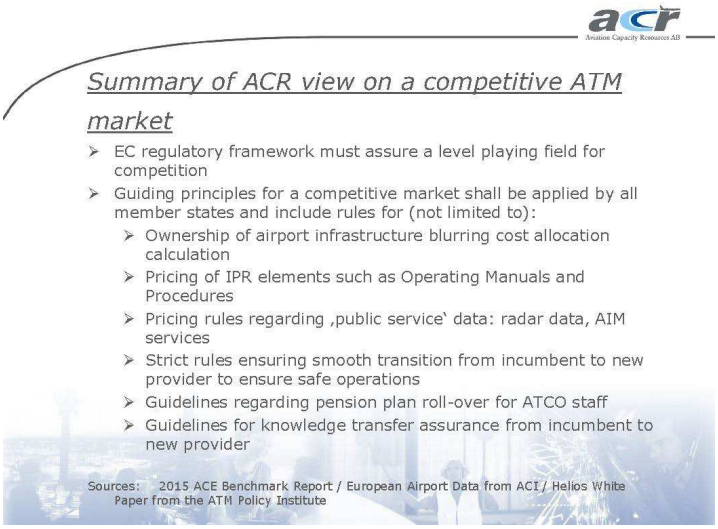
- Based on the operator / support ratio, real cost-efficiencies are achieved by establishing tailor-made, 'lean' organizations (not ATCO salaries)
- the creation of new business-, cooperation models (with suppliers, Partner organizations)



- ATC Provision as fully regulated industry: Training, separation criteria, quality assurance, financial stability, requirements to equipment, documentation, data integrity, working conditions, etc.
- Full compliance with the complete regulatory framework as pre-condition to a SES certification
- Other de-regulated industries have not seen decrease in safety levels

Summary of ACR view on a competitive ATM market

- Market Deregulation and introduction of competition is not the ‚golden bullet' that solves all problems
- Deregulation and competition does not tackle externalities such as capacity issues or the fragmented institutional framework but focuses primarily on cost savings achieved through competition
- Risks in liberalization: formation /development of a real monopoly or oligopolies (see supplier market)
- Un-ethical and pure capital maximising behaviour of new competitors must be prevented – Just culture, Human factor principles must be adhered to (as part of the certification process?)
- ATM as part of the National transport and emergency infrastructure service provision continuity must be assured
- Requires a strong regulative / legal framework – a situation that does not (yet) fully exist in Europe



3. COMPAIR – Unbundling

compair
Competition for Air Traffic Management

TRANSPORT & MOBILITY LEUVEN NOMMON האוניברסיטה העברית בירושלים THE HEBREW UNIVERSITY OF JERUSALEM Sofreavia consulting

COMPAIR 2

Tower control market - outline

- Interesting case
  - Some countries experimented already with tendering
  - It matters as it represents close to 20% of ANSP costs (1,4 Billion Euro in 2009)
- Research questions
- Benefits of competition in tower control
- Current status and experience
- Conditions for a successful market opening
- Understanding institutions via a game tree
- Conclusions

COMPAIR 3

Research questions

- What was the experience in different countries up to now?
- What are the necessary conditions for a market in tower control services to develop?
- How do "institutions" influence the market outcome?
- Can we quantify the benefits of tower control liberalisation?

COMPAIR 4

2 main benefits of market for tower control

- Cost reduction
  - Anecdotal evidence for Spain, Sweden ..that costs can be reduced strongly by using better organization, better technologies, lower pay for ATCO's...
- Transparency :
  - Many regional airports are heavily subsidized -one of the mechanisms is cross-subsidisation of tower control by other ANSP services
  - The best way to have transparent accounts is a bidding process.

Experience up to now

- Implementation Experience in UK, Spain , Germany, Sweden and Norway
- Refused implementation is also interesting but more difficult to study

UK	All airports open except Heathrow Incumbent = private company 3 out of 11 airports left incumbent Most airports renegotiated contract
Spain	Smaller airports open 12 towers operated by newcomers Still large inefficiencies in bigger airports
Germany	Regional airport towers opened to competition At least 14 towers left the incumbent
Sweden	Smaller airports liberalized At least 17 towers left the incumbent
Norway	Tender for second Oslo airport

UK experience is documented best

- UK has a competition tradition
- Civil Aviation Authority is responsible for cost-efficiency targets (EU-SES regulation for 7 largest airports) – that can be avoided if there is "enough" competition for tower services
- There was no legal monopoly for tower services but the incumbent did not like competitors
- Ownership of equipment (incumbent, airport) was not sufficient to block competition
- High share of ATCO's with very generous terms (salary, pensions) was also not blocking the market opening – as they were employed by the newcomers at unchanged conditions, new ATCO's had less beneficial conditions
- Almost all airports that did not organize a tender renegotiated their contract with the incumbent supplier and this may be as important as the tendering itself

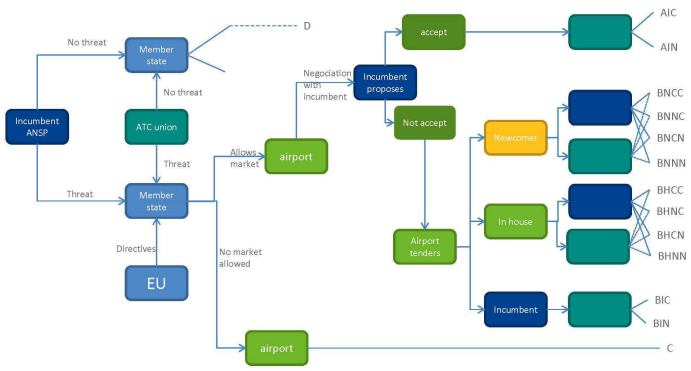
Founding Members
EUROPEAN UNION EUROCONTROL

What are conditions for a market to develop?

- Who pays for tower control and does cost control really matter for the airport?
  - Airports can be private, public or mixed
  - Evidence (Adler & Liebert, 2014) that private airports will always strive for lower costs and that also other airports strive for lower costs when airport encounters strong competition from other airports
- Is the bid taker likely to observe the procedure and select the lowest bid?
  - Legal battles by incumbent (in many sectors as it is important)
- Do all parties have the same information?
  - Winners' curse probably not so important
- Are there important economics of scale involved?
  - For one tower: yes there are economics of scale
  - Combining several towers?
  - Vertical: what is role of coordination between tower and en-route control and between tower and internal airport operation?

COMPAIR 8

Game – tree for institutional analysis: mapping of the decision process



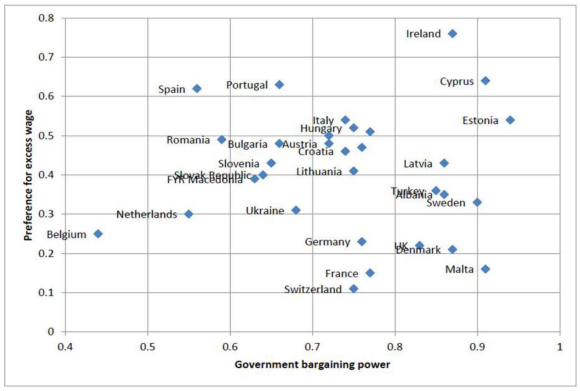
COMPAIR 9

Elements of the game tree: Agents, their strategies and objective functions

- ATC union: defend privileges (cfr. ACCHANGE results)
- Incumbent ANSP: keep market
- Newcomer: obtain market
- Airport: reduce costs if private and facing competition
- Member state: depends on institutions (competition tradition?) and on power of unions
- EU: max welfare of all users

COMPAIR 10

Unions bargaining power and preferences (ACCHANGE project)



Solution of the game 1

Starting left side
Incumbent and ANSP will always lobby government
If member state decides not to open : game stops

If member state decides to open: airport can start by negotiating and if it does not obtain better conditions, it can open the market

So outcome can be

a) renegotiation (saving transaction costs – important for smaller airports)

Or b) tender, then newcomers and in- house enter the game

If newcomers and in-house risk to win the bid, there will be lobbying by incumbent and union

Solution of the game 2

SOLUTION

If information on pay-offs (costs of different suppliers) is known by all players, the incumbent will be forced to bid the cost of the newcomer or in-house minus epsilon (Bertrand type of equilibrium).
– union will gets its share for the existing ATCO's

If information on pay-offs (costs of different suppliers) is more uncertain, this will mainly benefit the incumbent and the union who have an information advantage and can use a smaller hedge on costs

If game is repeated over and over again, building a reputation counts as this allows to make more credible threats.
- Important for unions to be "tough" - For incumbent, this may be different as not cooperating with a newcomer (through its en route services) may end up in organizing competition for en-route services too.

Founding Members
EUROPEAN UNION EUROCONTROL

Conclusions

1. Competition for tower control only exists in a few countries – it can be organized in all member states –EU can help to make this mandatory, let the lowest cost firm get the market --- but experience in other sectors (electricity) shows this can take a long time.

When tower control was liberalized, there was important resistance of unions and incumbent and these parties have strong bargaining power in some countries. Here the EU can come in and guarantee a European Market.

Crucial in the process are the airports themselves, this is an opportunity for them to reduce ATC costs (if they have to pay them) but not all of them are interested in cost control

2. Other ANSP services (MET,CNS..) can also be outsourced, but this is different because it are no longer the airports who decide but the ANSP itself. The ANSP faces less competition than an airport and will be less motivated to introduce competition

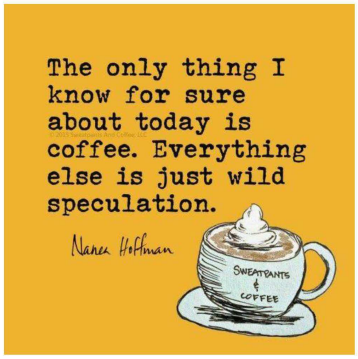
COMPAIR

Thank you very much for your attention!

This project has received funding from the SESAR Joint Undertaking under the European Union's Horizon 2020 research and innovation programme under grant agreement No 639249

Founding Members

Coffee



4. COMPAIR: Economic Modelling - the influence of ownership

Outline presentation

- Ownership models today in ATM
- Influence of ownership
  - Literature
  - (Small) economic model
  - What does the data have to say?
- Conclusions

COMPAIR 3

Effect of ownership?

Ownership and governance models

- A large variety over countries

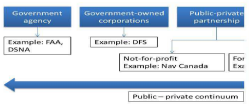
Country	ANSP	Towers	Centers	Employees	Organization
Australia	Airservices Australia	29	2	4,204	Gov't-owned corporation
Belgium	Belgocontrol	5	1	919	Public company
Canada	NAV CANADA	42	7	4,832	Private company
Finland	Finavia Corporation	25	1	1,612	Gov't-owned public limited corporation
France	DSNA France	86	5	7,846	State agency
Germany	DFS Deutsche Flugsicherung GmbH	16	4	5,938	Gov't-owned company
Greece	Hellenic Civil Aviation Authority	18	2	680	Civil service agency
Ireland	Irish Aviation Authority	3	2	642	Commercial state-sponsored body
Italy	ENAV, S.p.A.	40	4	3,276	Joint-stock company
Mexico	SENEAM	58	4	2,254	Gov't agency
New Zealand	Airways New Zealand	29	1	761	Gov't-owned corporation
Poland	Polish Air Navigation Services Agency (PANSA)	13	1	1,771	"Certified legal ensity"
Portugal	NAV Portugal	10	2	993	Gov't-owned company
Romania	Romanian Air Traffic Services Administration (ROMATSA)	16	1	1,516	Self-financed government administration
Russia	State ATM Corporation	250	57	9,500	Gov't-owned corporation
Slovenia	Slovenia Control, Slovenian Air Navigation Services, Ltd.	4	1	215	Independent gov't-owned company
South Africa	Air Traffic & Navigation Services (ATNS)	23	2	1,050	Gov't-owned corporation
Spain	AENA	22	5	4,249	Publicly owned company
Switzerland	skyguide	14	2	1,330	Nonprofit joint-stock company

COMPAIR 4

Effect of ownership?

Ownership and governance models

- Continuum of governance models



- Increased involvement of ATM cust

The privatisation of the FAA: Does it go far enough?

David McMillan, the former DG of Eurocontrol, Chair of the ATM Policy Institute, argues that Trump's proposed privatisation of the ATM network is a good but improvable decision.

President Trump's recent announcement that he is to 'privatise' the air traffic management of the Federal Aviation Administration is a welcome development.

It is not a true privatisation, but, if it can be achieved, it will help to eliminate the current roundabout of political interference and management-accountable-to-political-whimsy to which the Air Traffic Office of the FAA is currently subject, when it should instead be focusing on its customers: the airlines.

COMPAIR 5

Literature is mixed

- ANSPs
  - Elias (2015): no evidence one is better than the other
  - Button & Neiva (2014): DEA analysis: more efficient if closely linked to government ("counterintuitive")
  - Robyn (2015): "A cooperative approach, such as the NavCanada case, has shown to be superior, in theory and in practice"
- Airports
  - Adler & Liebert (2014): DEA analysis - public airports operated less cost efficiently than fully private airports (in absence of competition). If competition, equally efficient but private sets higher charges (EU & Australia)
- General economic literature
  - Focusses on incentives
  - Laffont & Tirole (1991), Armstrong & Sappington (2007) : Cannot know a priory which one is better
  - Sappington & Stiglitz (1987): role of transaction costs

What does theory have to say? (1)

Assume the following mixed goal function for ANSP

$$Goal^{ANSP} = \gamma_1^{ANSP_i} CS + \gamma_2^{ANSP_i} \pi^{ANSP} + \gamma_3^{ANSP_i} NI$$

- With consumer surplus (CS), with weight parameter $\gamma_1^{ANSP_i}$
- Maximization of profits (π^{ANSP}), with weight parameter $\gamma_2^{ANSP_i}$
- National interest (NI), with weight parameter $\gamma_3^{ANSP_i}$
- Argue that weights depend on ownership form

ANSP has operating costs

$$OC_{ANSP} = D \cdot c(e) = D \cdot (a + \theta - e)$$

- With D demand
- a - fixed cost per flightkm controlled
- θ ANSP dependent cost – imperfectly observable (eg. Function of complexity)
- e imperfectly observable cost reduction potential – which comes at a cost $C_e = D \cdot \frac{\emptyset \cdot e^2}{2}$

ANSP receives income via charges – mix of price cap and cost-plus – B is weight of cost-plus

$$p_{charge} = A + Bc(e)$$

What does theory has to say? (2)

We can show by differentiating objective function:
The first order condition leads us to the following choice of efficiency

$$e^* = \frac{\gamma_2^{ANSP_i} + B(\gamma_1^{ANSP_i} - \gamma_2^{ANSP_i})}{(\gamma_2^{ANSP_i} + \gamma_3^{ANSP_i})\emptyset}$$

Hence we find that

- Effort is increasing in the weight attached to consumer surplus ($\gamma_1^{ANSP_i} > \gamma_2^{ANSP_i}$) and ($\gamma_1^{ANSP_i} > \gamma_3^{ANSP_i}$) – except if pure price cap.
- Effort is decreasing in the weight attached to national interest
- The effect decreases with the weight attached to profit

Assuming that public firms care more about national interest, this could lead to a lower effort level than a private firm with consumers in the board.
If the private firm is mainly interested in profit, it is not clear if the effort would be larger or smaller than in the case of a public firm/private firm with board.

And if we look into the data?

Estimation of
- Cost function
- Production function

Separately for En Route & Terminal
Using a dataset 2006-2014
- Data quality testing
- Missing data
- Construction of variables

Used STATA – Stochastic Frontier Analysis
- Different specifications
- Different explanatory variables/sets of explanatory variables

En route

Enroute, cost

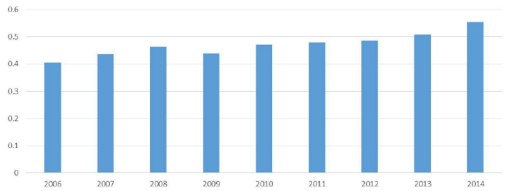
Para.	Label	Model 1 Estimate		SE	Model 2 Estimate		SE
Elasticities							
β_1	x_1 (Total IFR flight hours controlled)	0.919	**	0.016	0.905	**	0.018
β_2	x_2 (Labor cost)	0.385	**	0.035	0.417	**	0.041
β_3	x_3 (Capital cost)	0.216	**	0.021	0.218	**	0.022
Environmental variables							
β_{21}	Z_1 (Seasonality)	1.379	**	0.192	1.686	**	0.214
β_{22}	Z_2 (Complexity)				0.700	**	0.153
Exogenous inefficiency determinantsa							
δ_1	Z_{41} (Complexity)				-0.846	**	0.133
δ_2	Z_{42} (Ownership gov/corp)				1.596	**	0.337
δ_3	Z_{43} (Ownership agency)				1.563	**	0.344
	sigma_u	**0.080**		**2.463**	**0.296**	**	**0.025**
	sigma_v	**0.327**	**	**0.013**	**0.181**	**	**0.022**
	lambda	**0.246**		**2.466**	**1.633**	**	**0.041**
	Log Likelihood	**-97.510**			**-57.280**		

Enroute, production

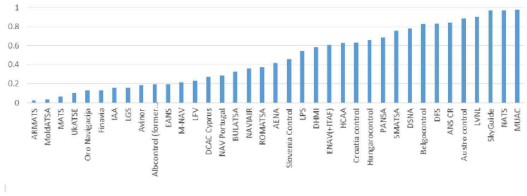
Para.	Label	Model 1 Estimate		SE	Model 2 Estimate		SE
β_1	x_1 (Labor)	0.451	**	0.074	0.423	**	0.060
β_2	x_2 (Capital)	0.582	**	0.084	0.520	**	0.064
β_{21}	Z_1 (Seasonality)	-1.017	**	0.232	-2.492	**	0.200
β_{22}	Z_2 (Complexity)				-0.989	**	0.102
δ_1	Z_{41} (Complexity)				-1.553	**	0.102
δ_2	Z_{42} (Ownership gov/corp)				2.935	**	0.225
δ_3	Z_{43} (Ownership agency)				2.623	**	0.232
	sigma_u	**3.723**		**25.244**	**0.340**	**	**0.023**
	sigma_v	**0.271**	**	**0.029**	**0.142**	**	**0.019**
	lambda	**13.745**		**25.237**	**2.395**	**	**0.057**
	Log Likelihood	**-150.271**			**-59.249**		

A */** next to coefficient indicates significance at the 5%/1% level.
[a] A positive efficiency score parameter estimate shows that the variable has a negative effect on efficiency

Average production efficiency for en-route ANSPs from 2006-2014



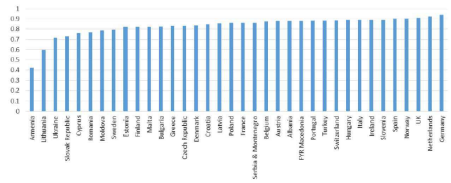
Average production efficiency estimate per en-route ANSP



And for terminals?

- Problem that terminals are reported at national level – aggregate of small and large airports
- All variables are statistically significant and with expected sign
  - Ownership significant for cost function
  - But not for the production function

Average production efficiency



Conclusion

In theory, one would expect positive effects (higher effort to control costs) of

- privatisation with stakeholders as shareholders
- inclusion of a board of stakeholders (public company)
- Impact of strong national interests (buying local, unions) decrease efficiency.

We also find this back in the data

-> ownership matters!

Questions?

Eef.Delhaye@tmleuven.be
http://www.compair-project.eu/

5. Air Traffic Control: achieving the goals of the Single European Skies initiative

Motivation

- **present ATC system in EU is composed of 37 national providers**
  - compared to FAA, EU system is 34% more costly (2011)
- **barriers to cost efficiency:**
  - *ownership form*: governmental organizations
  - *fragmentation*: missing economies of scale
  - *protectionism*: power of labor unions & national interest
  - *weak regulation*: failure to implement FABs or strict price-caps
- **barriers to increasing capacity:**
  - opposition to change
  - fear of technology
  - relatively low congestion currently

Adler et al. 2017, Deliverable 4.1, COMPAIR 3

how could cost efficiency and technology adoption be encouraged simultaneously?

- **changes in ownership form**
  - horizontal integration
  - vertical integration
  - privatization
- **changes in pricing regulation**
  - strict individual price-caps
  - peak / off peak charges
  - no regulation
- **changes in capacity**
  - SESAR technologies

Adler et al. 2017, Deliverable 4.1, COMPAIR 4

Outline of talk

- Methodology to analyse aviation market
  - 2-stage game
- Case study
  - Western Europe
- Conclusions & Future Research

Adler et al. 2017, Deliverable 4.1, COMPAIR 5

Government Auction Decisions

In stage 0, European Union sets:

- Maximum number of auctions in which en-route ATC providers are permitted to compete

Member States set:

- Minimum level of service
  - for example maximum average delay
- Percentage increase/decrease in charge permitted for providing output above/below the minimum service level requirement

2 Stage Game

- **Stage 1: Air Traffic Control Providers choose *charges*, *labor* & *technology* levels**
  - ANSPs bid peak & off-peak charges
    - may be price capped according to regulatory rules
  - capacity = *f* (labor levels, technology investment, size of airspace)
  - ATC terminal limits flights in peak
    - form of slot allocation
- **Auction:**
  - sealed bid, lexicographic
    - 1st peak price; 2nd off-peak price; 3rd home bias; 4th capacity
  - complete information
  - combinatorial with inter-dependent valuations

2 Stage Game

- **Stage 2: Airlines choose flight paths given schedules**
  - 3 cost components: operational, congestion & ATC charges
    - All cost components impacted by ATC provider decisions in 1st stage
    - Operational and congestion costs are a function of technologies employed
  - Revenue loss: flying off-peak lowers airfares
  - Option to 'not fly' necessary for demand elasticity
  - Note:
    - Congestion is non-linear
    - Closer to capacity: the higher the delays

3 scenarios: with(out) tenders

- With tenders: limit on number of auctions permitted to participate
- Business as Usual government organization
  - set charges restricted by price caps
  - maximize labor rent
  - examples: DFS (Germany) and DSNA (France)
- Non-profit public companies
  - set charges to cover costs
  - maximize capacity according to company charter
  - airlines on Board of public company
  - example: NavCanada
- For-profit private companies
  - maximize profits
  - example: NATS (public-private partnership in UK)

Technology level (1=current standards; up to 2=SESAR Step 1)

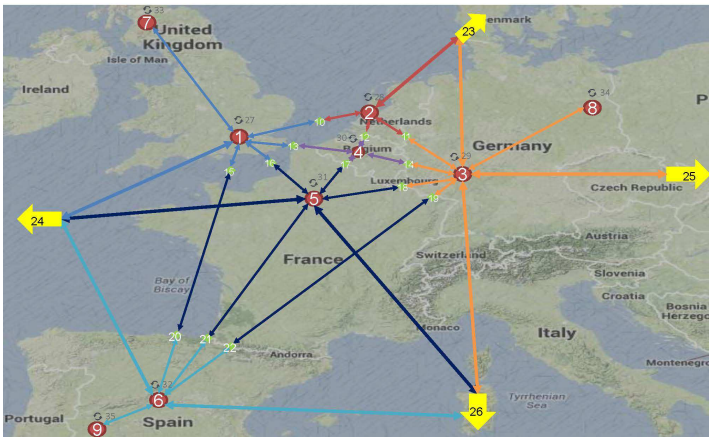
Adler et al. 2017, Deliverable 4.1, COMPAIR 9

Outline of talk

- Methodology to analyse aviation market
  - 2-stage game
- **Case study**
  - **Western Europe**
- Conclusions & Future Research

Adler et al. 2017, Deliverable 4.1, COMPAIR 10

Case Study of Western Europe



Players

- **Up to 12 potential en-route air navigation service providers:**
  - **serve ~50% of EU traffic**
  - **two from each country**
  - U.K.
  - Netherlands
  - Germany
  - Spain
  - Belgium
  - France
- **5 Airlines:**
  - 3 alliances:
    - Star (Lufthansa)
    - Oneworld (BA)
    - SkyTeam (AF-KLM)
  - Low cost carrier (EasyJet)
  - Unaligned carrier (Emirates)

Adler et al. 2017, Deliverable 4.1, COMPAIR 12

Results: no tender (1/6)

Business as usual	Price in € per peak / off-peak per km												Labour	Tech level	Revenues (000 €)	Profits (000 €)
ANSPs	UK		Netherlands		Germany		Belgium		France		Spain					
NATS	1.11	1.11											605	1.00	737,598	283,054
LVNL			0.61	0.61									172	1.00	207,680	17,067
DFS					0.81	0.81							1,472	1.00	1,071,714	223,823
Belgocontrol							0.95	0.95					310	1.00	267,411	25,965
DSNA									0.81	0.81			2,442	1.00	1,720,356	190,538
ENAIRE											0.86	0.86	805	1.00	663,726	204,237
Annual Totals													5,806		4,668,486	944,683

- Labor rent seekers:
  - Prices set at price cap
  - Labor levels similar to current employment
  - Technology levels mean no investment beyond current levels
  - Today profits are approx. 20%

Results: for profits & no tender (2/6)

For profit No tender	Price in € per peak / off-peak per km												Labour	Tech level	Revenues (000 €)	Profits (000 €)
ANSPs	UK		Netherlands		Germany		Belgium		France		Spain					
NATS	1.11	1.11											486	1.09	716,431	296,770
LVNL			0.61	0.61									147	2.00	119,713	-56,455
DFS					0.81	0.81							832	2.00	1,123,545	430,170
Belgocontrol							0.95	0.95					184	2.00	245,849	77,849
DSNA									0.81	0.81			1,084	2.00	1,734,423	857,537
ENAIRE											0.86	0.85	408	1.16	563,417	241,705
Annual Totals													1,233		4,503,379	1,847,575

- For profit compared to Labor rent seekers:
  - Prices set at price cap in both situations
  - Labor levels massively lower in this scenario
  - Technology levels increase in 4 of the 6 regions
  - Profits double (so airlines not better off)

Results: for profit with tender (3/6)

For-profit 2014 ANSPs	Price in € per peak / off-peak per seat per km												Labour	Tech level	Revenues (000 €)	Profits (000 €)
	UK		Netherlands		Germany		Belgium		France		Spain					
6. Germany			0.45	0.45	0.45	0.45							1,021	2.00	790,995	8,096
7. Belgium	0.32	0.32					0.49	0.49					276	2.00	243,748	9,242
10. France									0.29	0.29	0.43	0.43	1,219	2.00	999,481	44,963
Annual Totals													2,517		2,034,225	62,302

- Only 3 companies remain
  - Germany/Holland; UK/Belgium; France/Spain
- Labour levels halved compared to base case
- SESAR technologies adopted in full
- Revenues halved compared to current equilibria outcome
  - UK & France prices drop by 2/3, Germany, Spain & Belgium by ½, Netherlands by 1/3
- Profits reduced & Airlines far better off…

Adler et al. 2017, Deliverable 4.1, COMPAIR 15

Forecasted growth in demand to 2035

Challenges of Growth 2013 Task 4

ANSP	Total IFR controlled in 2014 (000 km)	expected IFR in 2035 (000 km)			
		Global growth (2.6% annually 2014-2035)	Regulated growth (1.8% annually 2014-2035)	Happy localism (1.6% annually 2014-2035)	Fragmenting world (0.7% annually 2014-2035)
Belgocontrol	173,363	297,202	252,151	241,949	200,713
DFS	1,103,673	1,892,060	1,605,253	1,540,310	1,277,789
DSNA	1,542,051	2,643,584	2,242,859	2,152,120	1,785,326
ENAIRE	882,224	1,512,423	1,283,164	1,231,251	1,021,404
LVNL	209,565	359,263	304,805	292,473	242,626
NATS	798,502	1,368,896	1,161,393	1,114,407	924,474
Compound growth		167%	143%	137%	115%

Adler et al. 2017, Deliverable 4.1, COMPAIR 16

Forecasted growth in demand to 2050

Challenges of Growth 2013 Task 4

ANSP	Total IFR controlled in 2014 (000 km)	expected IFR in 2050 (000 km)			
		Global growth (2.8% annually 2035-2050)	Regulated growth (1.8% annually 2035-2050)	Happy localism (1.7% annually 2035-2050)	Fragmenting world (-0.4% annually 2035-2050)
Belgocontrol	173,363	449,726	329,516	311,558	189,002
DFS	1,103,673	2,863,067	2,097,781	1,983,455	1,203,231
DSNA	1,542,051	4,000,276	2,931,019	2,771,282	1,681,154
ENAIRE	882,224	2,288,601	1,676,868	1,585,481	961,807
LVNL	209,565	543,638	398,326	376,618	228,469
NATS	798,502	2,071,415	1,517,734	1,435,020	870,532
Compound growth		259%	190%	180%	109%

Adler et al. 2017, Deliverable 4.1, COMPAIR 17

Results: with tender (4/6)
For Profit ATC providers with 'global growth'

For-profit Global 2050 ANSPs	Price in € per peak / off-peak per seat per km												Labour	Tech level	Revenues (000 €)	Profits (000 €)
	UK		Netherlands		Germany		Belgium		France			Spain				
6. Germany			0.42	0.42	0.55	0.55							2,457	2.00	2,191,505	727,025
7. Belgium	0.29	0.28					0.44	0.44					552	2.00	541,334	107,599
10. France									0.26	0.26	0.83	0.80	3,076	2.00	3,200,472	1,179,477
Annual Totals													6,085		5,933,310	2,014,101

Adler et al. 2017, Deliverable 4.1, COMPAIR 18

Results: with tender
Impact on Airlines

	User Equilibrium business as usual			Profit Maximization under auctions			Profit Maximization under auctions global demand 2035		
Airlines	cask	peak %	offpeak %	cask	peak %	offpeak %	cask	peak %	offpeak %
LH	0.104	78	15	0.100	82	16	0.103	68	8
BA	0.089	81	18	0.085	81	19	0.088	80	17
AF	0.084	83	17	0.081	83	17	0.084	83	17
LC	0.073	87	13	0.069	74	26	0.070	36	64
Rest	0.083	87	9	0.080	87	12	0.082	86	13

Adler et al. 2017, Deliverable 4.1, COMPAIR 19

Results: with tender (5/6)
Non-profit ATC providers

Non-profit 2014 ANSPs	Price in € per peak / off-peak per km												Labour	Tech level	Revenues (000€)	Profits (000 €)
	UK		Netherlands		Germany		Belgium		France			Spain				
1 UK	1.01	0.79											295	1.00	318,158	31
5 Germany			0.15	0.15	0.81	0.76							625	1.92	583,224	497
7 Belgium							0.81	0.81					100	1.53	98,413	(408)
10 France									0.24	0.24	0.75	0.75	939	2.00	794,344	953
Annual Totals													1,959		1,794,139	1,073

- 4 companies survive
  - UK; Germany/Netherlands; Belgium; France/Spain
- Charges: more competitive regions cheaper than for-profit outcome & some peak ⬌ off-peak charges
- Mixed pattern of SESAR technology adoption & fewer ATCOs than for-profit
- Overall: unstable since one ANSP achieving negative profits

Adler et al. 2017, Deliverable 4.1, COMPAIR 20

Results: without tender (6/6)
Non-profit ATC providers

Non profit No tender ANSPs	Price in € per peak / off-peak per km UK	Netherlands	Germany	Belgium	France	Spain	Labour	Tech level	Revenues (000 €)	Profits (000 €)
NATS	0.83	0.83					277	1.00	308,505	(1,739)
LVNL		0.61	0.61				231	2.00	210,092	(53,533)
DFS			0.61	0.61			597	1.83	533,629	(23,154)
Belgocontrol				0.95	0.95		274	2.00	211,654	(21,224)
DSNA					0.61	0.61	487	2.00	498,883	(34,898)
ENAIRE						0.64 0.64	206	1.00	218,833	(65)
Annual Totals							2,072		1,981,597	(134,613)

- Without tender; for-profits charge price cap whereas non-profits choose lower charges
- BUT… non-profits have difficulties balancing profits and capacities

Adler et al. 2017, Deliverable 4.1, COMPAIR 21

General conclusions

Modeling ATC via 2-stage game enables cost-benefit analysis including distributional effects across stakeholders

Single European Skies Initiative:

- Lower costs
  - defragmentation via FABS
  - price regulation
- Increased capacity
  - SESAR

How to achieve these goals? auction ATC provision en-route

- similar to that of airport terminal provision in Spain, Sweden, UK…
- leads to defragmentation of European airspace
  - around 5 companies will survive if market share cap of 20%
- charges as much as halved
  - potentially removes need for price regulation

Adler et al. 2017, Deliverable 4.1, COMPAIR 22

Conclusions

Auction Rules:

- Very important: multiple bidders
- Pressures on capacity thus need to set minimum levels
- Could permit charges to increase/decrease as function of service levels

Regulation:

- Safety regulators (EASA, NSA…) need to continue
- Data collection (STATFOR) would need to continue to check capacity levels
- Economic regulator (PRB) may be less necessary

Ownership form:

- For Profits: most effective solution
- Non-Profits: provides a solution between current equilibria outcome and for-profit potential solution

Adler et al. 2017, Deliverable 4.1, COMPAIR 23

6. An Agent-Based Model of Competition in ATM

-

compair
Competition for Air Traffic Management

An Agent-Based Model of Competition in ATM (COMPAIR Workshop, Brussels, 20th October 2017) 2

Content

An Agent-Based Model of Competition in ATM (COMPAIR Workshop, Brussels, 20th October 2017) 3

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)

Purpose | Tendering of ATM licenses | Sector-less ATM

An Agent-Based Model of Competition in ATM (COMPAIR Workshop, Brussels, 20th October 2017) 4

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

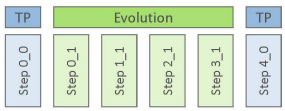
Tendering of licenses to operate ATS in specific geographical areas

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



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.

Purpose | Tendering of ATM licenses | Sector-less ATM

An Agent-Based Model of Competition in ATM (COMPAIR Workshop, Brussels, 20th October 2017) 8

Agents

Regulator

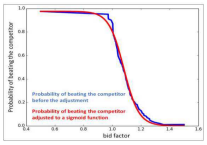
- Announce auction parameters, select winners, store data

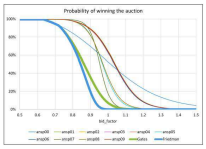
ANSPs

- 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

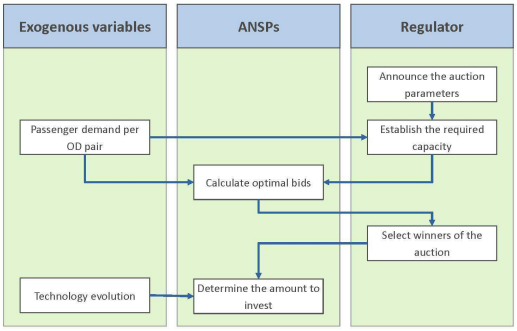




Purpose | Tendering of ATM licenses | Sector-less ATM

An Agent-Based Model of Competition in ATM (COMPAIR Workshop, Brussels, 20th October 2017) 9

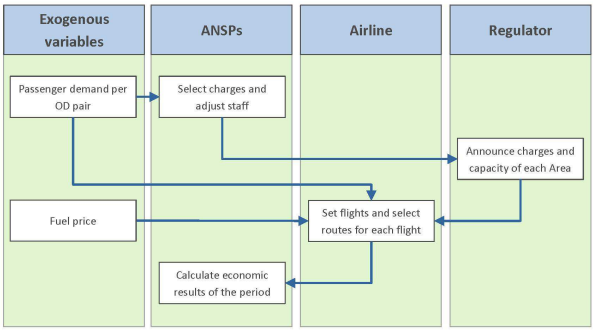
Agents' interaction rules Tendering process



Purpose | Tendering of ATM licenses | Sector-less ATM

An Agent-Based Model of Competition in ATM (COMPAIR Workshop, Brussels, 20th October 2017) 10

Agents' interaction rules
Evolutive process



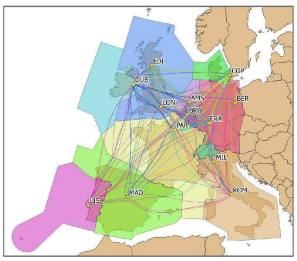
Case study

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



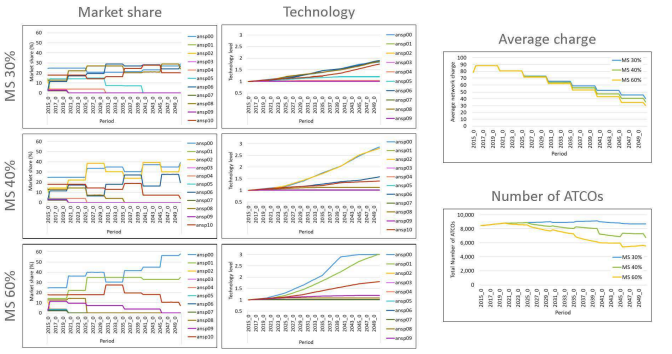
Demand forecast:
- Challenges of growth 2013 Task 7, "Regulated growth"

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

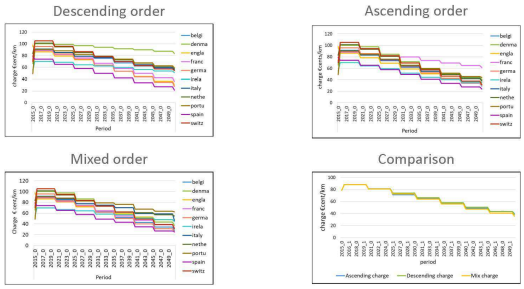
Simulation scenarios
Maximum market share allowed



Purpose | Tendering of ATM licenses | Sector-less ATM

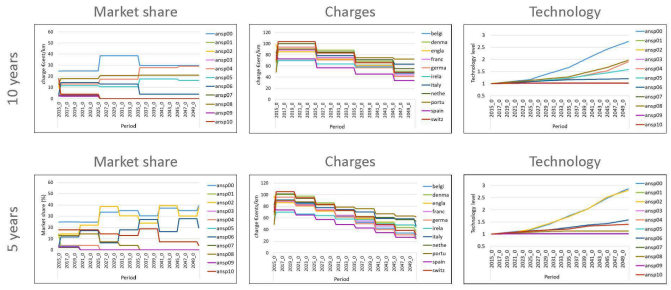
Simulation scenarios
Auctioning order

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



Purpose | Tendering of ATM licenses | Sector-less ATM

Simulation scenarios
Licenses duration



Purpose | Tendering of ATM licenses | Sector-less ATM

Analysis of results
Interactive tool

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.

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

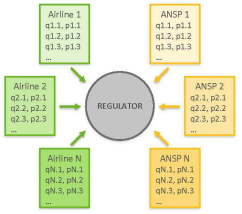
Provision of en-route air traffic services on a sector-less OD pair basis

Purpose | Tendering of ATM licenses | Sector-less ATM

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)



Purpose | Tendering of ATM licenses | Sector-less ATM

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.

Purpose | Tendering of ATM licenses | Sector-less ATM

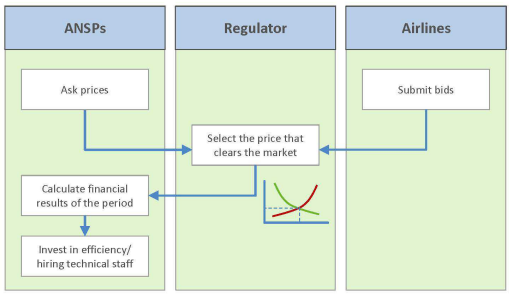
Agents

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

Agents' interaction rules



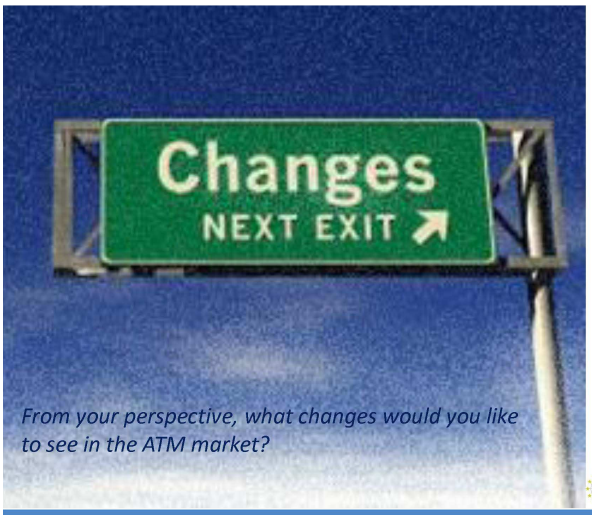
Scenarios and Research questions

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

7. COMPAIR Panel discussion



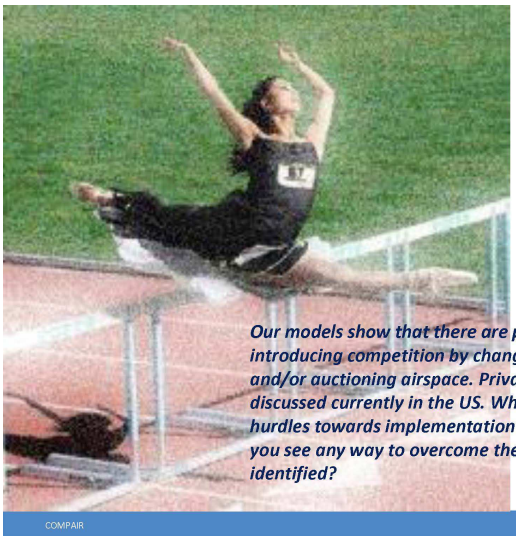
From your perspective, what changes would you like to see in the ATM market?

In your opinion how likely is it that by 2030 the European Air Traffic System will be managed in a competitive environment?

What is the level of competition you envisage by that time?

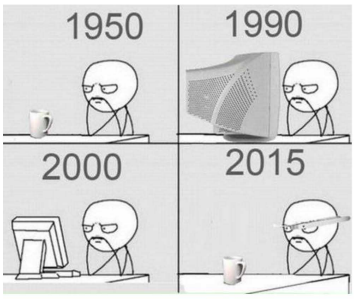
What kind of competitive scenarios do you think are the most likely to be adopted and why?

COMPAIR 5



Our models show that there are potential benefits of introducing competition by changing ownership form and/or auctioning airspace. Privatization is also being discussed currently in the US. What would be the main hurdles towards implementation of these concepts? Do you see any way to overcome the hurdles that you identified?

COMPAIR 6



We have used the notion of sector-less ATC provision as an enabler for introducing competition. It could also lead to more concentration.
Do you think that technological developments will increase or decrease the level of competition?

COMPAIR 7

What kind of impact could non-traditional aircraft (e.g. drones, semi and remotely and automatically-piloted vehicles) and their operators have on the current ATM market both from a technological and financial perspective?