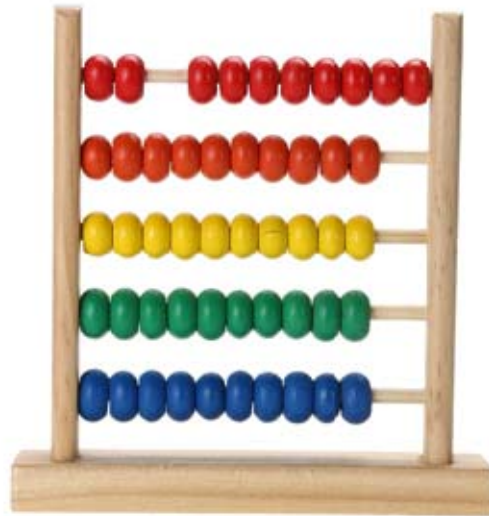


EUROCONTROL

Agency Research Team



Proceedings of the

ART Workshop

‘Aviation Economics and Business Models’

ENAC, Toulouse

16th - 17th April 2019

V1.0

Introduction

The Agency Research Team (ART) is the EUROCONTROL Agency's stakeholder consultation team for R&D and advises on Agency/SESAR research programmes and reviews relevant research content. ART meets twice a year and, in addition, holds dedicated workshops on selected topics. Ten workshops - open to participation from non-ART members - have taken place:

- Data Science in Aviation – May 2014, Brétigny
- The ATM Innovation Lifecycle – September 2014, Brussels
- Validation and Measuring ATM Performance – May 2015, Brétigny
- Remotely Piloted Aerial Systems and their Impact on ATM – September 2015, Vilnius
- ATM Security and Cybersecurity – March 2016, Toulouse
- Airport Capacity – September 2016, Madrid
- Weather and Atmospheric Science – April 2017, London
- Automation – October 2017, Vienna
- CNS and Infrastructure – March 2018, Braunschweig
- Machine Learning and Artificial Intelligence – September 2018, Brétigny (in collaboration with the Federal Aviation Administration)

Presentations and information about upcoming workshops can be downloaded from a dedicated [website](#).

The workshop 'Aviation Economics and Business Models' took place on 16th and 17th April 2019 at the ENAC premises in Toulouse, France and was attended by around 70 participants. This document presents the agenda, abstracts of the invited talks, a brief summary of the conclusions and debate at the end of the workshop and the list of participants. For more information, please consult the ART website or contact dirk.schaefer@eurocontrol.int.

Agenda

Day 1: 16th April 2019

| Time | Subject | Presenter |
|--|---|--|
| 9:30 | Welcome and Context Setting | Olivier Chansou, ENAC Dirk Schaefer, EUROCONTROL |
| Session 1: Market Mechanisms | | |
| 9.45 | Airports as two-sided platforms | Estelle Malavolti, Toulouse School of Economics / ENAC |
| 10.15 | Impact of innovation on air transport organization | Isabelle Laplace, ENAC |
| 10.45 | --- Coffee --- | |
| 11.15 | Perspectives for Aerospace Research in Europe: recommendations relevant for airline economics and finance | Luiz Braga Campos, Técnico Lisboa |
| 11:45 | Evaluating economic benefits of air traffic management projects | Kirsteen Purves, EUROCONTROL |
| Session 2: Business Models | | |
| 12:15 | Measuring the impact of leasing on airlines' cost efficiency: a stochastic frontier analysis | Catherine Muller, Toulouse Business School |
| 12:45 | --- Lunch --- | |
| 14:00 | Airport economic value – informing business models | Denis Huet, EUROCONTROL and Gérald Gurtner, University of Westminster |
| 14:25 | Airports in the mobility chain – challenging business models | Andrew Cook, University of Westminster |
| 14:50 | Measuring airline networks | Chantal Roucolle, ENAC |
| Session 3: Demand-Supply Management | | |
| 15:20 | Regulation and market incentives in aviation | Inge Mayeres, TML Leuven |
| 15:50 | --- Coffee --- | |
| 16:15 | COCTA: Coordinated capacity and demand management in a redesigned Air Traffic Management value-chain | Radosav Jovanović, University of Belgrade |
| 16:45 | Entry games for the airline industry | Christian Bontemps, Toulouse School of Economics / ENAC |
| 17:15 | Workshop debate and conclusions | Dirk Schaefer, EUROCONTROL |
| 17:30 | End of day 1 | |

Day 2: 17th April 2019

| Time | Subject | Presenter |
|--|--|---|
| 9:30 | Recap Day 1 | Dirk Schaefer, EUROCONTROL |
| 9.45 | An adjustable Route Charges Mechanism | René Verbeek, NLR |
| 10.15 | Market power and volatility in the airline industry | Philippe Gagnepain, Paris School of Economics |
| 10.45 | --- Coffee --- | |
| Session 4: Passenger-centric approaches | | |
| 11.15 | Passenger behavior and use of travel time in multimodal door to door travel experience | Nathalie Lenoir, ENAC |
| 11:45 | A multi-layer model for assessing regulatory and business change | Gérald Gurtner, University of Westminster |
| 12:15 | Debate and conclusions | Dirk Schaefer, EUROCONTROL |
| 13:00 | --- Lunch --- | |
| | End of day 2 | |

Abstracts

Airports as two-sided platforms

Estelle Malavolti, Toulouse School of Economics / ENAC

Large hub-airports profits are more and more often coming from commercial activities such as retailing. However, commercial services are relatively far from the original mission of the airport: providing airlines with aviation services such as ground handling, terminal management or airside operations, and being regulated for that because of an obvious dominant position with respect to airlines. For this reason, one can advocate for the separation of the two activities, i.e. for a dual till approach, in which only the aeronautical activity is regulated. We, instead, suggest that a single till regulation, in which the total profit of the airport is examined, is relevant because it allows to take into account the externalities existing between retailing and aeronautical services. Using a two-sided market approach (Armstrong 2006, Rochet-Tirole 2003, 2006), we show that the airport is a platform which makes the shops and the passengers meet. The retailing activity depends on how many passengers are circulating and connecting at the airport, as well as the time they spent in the airport, while passengers value the least connecting time as possible. We show that the aeronautical tax can be either higher or lower under single till depending on whether the impact of the passengers demand or of the waiting time is the more important for the shops.

Impact of innovation on air transport organization

Isabelle Laplace and Chantal Roucolle, ENAC

Innovations in the airline industry can have a significant impact on the behavior of air transport stakeholders: airline companies, airports and passengers. In this work, we address the question of the impact of the use of innovation on competitors' behaviors. We consider as innovation the introduction of the Airbus 380 (A380) which is currently the largest aircraft available. Using a monthly panel data set on airlines' supply over 10 years, on 118 routes, we assess on one hand, the probability for an A380's owner to operate this aircraft type on a route, given its own attributes as well as the route's characteristics. On the other hand, we test whether the use of the A-380 impacts airlines' flight frequency at the route-level.

We show that airline's incentive to use the innovation is driven by its competitors' use of the same innovation on the route, or even to the threat that competitors use this innovation on the route. Our model also confirms that congestion issues at airports are significant drivers for adopting the A380 innovation. However, economic recessions and fuel price increases would not be in favor of the A380 adoption. We show that the incentives to use innovation decrease as the market power of the competitors increases on the route. These results highlight the importance of airlines' market positioning on their strategic choices to adopt the innovation.

Our results also suggest that flight frequency is sensitive to the use of innovation: a heavy use of the A-380 leads airlines to reduce their own flight frequency. We also find that when facing the introduction of the A-380 on a route, airlines will tend to react by increasing their own flight frequency. All these results highlight the importance of airlines' market positioning on their strategic choices of innovation.

Perspectives for Aerospace Research in Europe: recommendations relevant for airline economics and finance

Luiz Braga Campos, Técnico Lisboa

The Aeronautical Research Programme of the European Union has benefited from high-level guidance from the ACARE Panel that has produced several documents, including Flightpath 2050: a set of 24 ACARE Goals to be achieved by 2050 to ensure the smooth progress and growth of aviation. The PARE project reviews the progress made so far towards each of the 24 ACARE Goals and suggest appropriate measures to close the remaining gap. The PARE report adds a set of 34 PARE Objectives that act as a

complement to achieve the 24 ACARE Goals. The 24 ACARE Goals plus the 34 PARE Objectives form a set of 58 Recommendations to the European Commission for Aeronautics Research in the Horizon Europe program for 2019-2025.

The presentation focuses on a subset of the PARE Recommendations concerning the technological issues and developments that are most likely to affect airline finance and economics in the next 3 decades. It covers a wide spectrum of topics between two extremes: (a) on one end the current issues, that will not disappear and could potentially limit the growth of aviation, such as airspace capacity and airport noise; (ii) at the other end the dreams of emerging technologies that could revolutionize current practice, such as local just in time additive manufacturing of spare parts that could replace spare part stocks and orders. Between these two ends of the spectrum a variety of progressing and emerging technologies relevant to aviation are considered.

Evaluating economic benefits of air traffic management projects

Kirsteen Purves, EUROCONTROL

It is often mentioned that it takes years to get a good ATM idea into operations, why? One reason is that R&D focuses on developing the concept, the tools, the procedures, etc. but decision makers also want to know whether the project is economically feasible and worth being developed further.

To help bridge this gap, most SESAR projects are required to develop a Cost-Benefit Analysis for the implementation of their Solutions to give a clearer view on how much it will cost and what benefits it will bring. This presentation looks at some of the approaches being used to monetise the performance benefits quantified during validation exercises.

Measuring the impact of leasing on airlines' cost efficiency: a stochastic frontier analysis

Sylvain Bourjade, Catherine Muller-Vibes, Toulouse Business School

In this paper, we evaluate whether airlines' choices of leasing, often driven by financial considerations, have an impact on airlines operational economic efficiency. Indeed, a leased aircraft can be operated for a period lower than its entire life, with limited upfront capital requirement, the ownership risks and rewards remain with the lessor and the assets are off the lessee's balance sheet. Leasing also allows airlines to recover some flexibility when making fleet decisions.

For this economic efficiency analysis, we choose the stochastic frontier approach. The estimation of cost efficiency, which we choose to apply here, assumes a behavioral objective of producers, which is relevant in a context where firms must reduce their costs to improve their performance. Technically speaking, a cost frontier characterizes the minimum expenditure required to produce a certain bundle of outputs, given the prices of the inputs used in its production and given the technology in place. Producers operating on their cost frontier are economically efficient whereas producers operating above their cost frontier are economically inefficient. The economic inefficiency is then defined as the distance to the cost frontier.

We adopt a Cobb-Douglas specification for the estimation of our cost function. We measure output as the number of available seat-kilometers (we will test our estimation with other measures of output). We consider labor, energy, maintenance, materials and services as inputs, and their prices are average salary, oil price, maintenance price (defined as maintenance costs divided by number of aircraft in the fleet) and materials and services price as all other operating costs divided by the number of passengers respectively. We control for capital as the book value of the fleet. We introduce other control variables like the business model, the density of competition in the market, corporate governance and macroeconomic variables.

For this paper, we build a database containing yearly financial and operating data on 248 airlines worldwide, during a period of 10 years (from 2007 to 2016). The data we use in our estimation come from The Airline Analyst, the US Department of Agriculture Research service, the KPMG corporate tax surveys and finally from companies' websites.

Our preliminary estimation exhibits a good statistical quality, with most parameters being significant at the 5% level. Economically, the parameters have the expected sign and the cost function displays constant returns to scale. Our main result is that leasing has a convex impact on expenditures: via its effect on cost inefficiency. In other words, inefficiency exhibits increasing marginal returns to leasing. There exists an optimal level of leasing that minimizes inefficiency. Thanks to our rich dataset we are able to provide accurate measures of airlines' economic inefficiency.

Airport economic value – informing business models

Denis Huet, EUROCONTROL and Gérald Gurtner, University of Westminster

This study proposes a method to evaluate the optimum capacity of an airport with respect to its economic value. The optimum point balances the cost of expanding the capacity with the direct and indirect costs related to capacity shortage (cost of delay). Building on a robust and well accepted methodology developed by EUROCONTROL over the years for the calculation of en-route optimum capacity, this study made use of a wide set of airport data (operational, economical, financial, quality of service (passengers and airlines satisfaction), etc...) and suggests to consider a number of factors, including the cost of average delay, the cost of uncertainty, the soft cost from passengers, and retail sales.

Airports in the mobility chain – challenging business models

Andrew Cook, University of Westminster

This presentation explores some of the challenges associated with delivering the ACARE 4-hour door-to-door journey target for 2050. In particular, it examines the context of passenger airport dwell times in this process and the elements and drivers thereof. Drawing on large survey evidence from a major European hub, some key trends are presented and their corresponding impact on dwell times are explored. Some airport responses to stressed business models are discussed in parallel to challenges associated with airline-based solutions to increasing journey resilience. A key objective of the presentation is to prompt discussion regarding future travel paradigms and delivering improved service to the passenger.

Measuring airline networks

Chantal Roucolle, Tatiana Seregina, ENAC/Toulouse Business School and Miguel Urdanoz, Toulouse Business School

The present study provides an analysis of airline network structure. We build indicators measuring the airline network development in order to characterize airline network strategies of expansion. We collect from OAG data on domestic and international scheduled flights operated by US carriers in 2007-2018 and build four indicators describing the evolution of the carriers' flight networks. These indicators are continuous and replace the dummies typically used to distinguish between hub and spoke and point to point networks. Indeed, the literature often compares these two extreme cases, however, reality is more complex and airline network organizations often lies between the two. These indicators are constructed using a Principal Component Analysis over eleven graph theory measures and a connectivity measure for indirect flights offered by airlines. Two of the built indicators cover spatial dimensions of the network changes. The first one describes the presence of central cities in terms of route concentration. The second indicator measures growth of the network density and its interlacing. The third indicator reflects the airline connectivity, that is, the percentage of potentially connected flights as in Alderighi et al. (2007). The last indicator measures the airline size in terms of the number of markets served by the airline. The four indicators together measure quantitatively the evolution of the airlines networks in terms of centrality, resilience, connectivity and size. Our further objective is to assess the impact of the network characteristics on airlines' performances, particularly on delays.

Regulation and market incentives in aviation

Inge Mayeres, TML Leuven

Part I (Flightpath): In our analysis we aim to assess the impacts of several policy instruments for the uptake of sustainable fuels on the aviation fuel market and the related fuel markets. The assessment uses a partial equilibrium model for the fuel markets for aviation, road transport and maritime transport in the EU and the rest of the world. The policy instruments considered are (grandfathered) tradable emission permits, blending mandates, biofuel subsidies and taxes on kerosene. The scenarios include scenarios with the EU RED II and CORSIA as a starting point, with a number of variants. The different policy scenarios are compared in terms of fuel demand, share of sustainable fuels, consumer surplus, producer surplus, government revenue, greenhouse gas emissions and welfare cost per tonne of CO₂ reduction. On this basis policy recommendations are made.

Part II (COMPAIR): Europe is a patchwork of markets in ATM service provision. The question is: which market structure is most favourable to increasing the performance of ATM, including airports? The answer is a complex one that was addressed by the partners in the SESAR 2020 project COMPAIR. This project looked at a number of options that could increase competition, including performance regulation with variations in ownership and governance models; tendering of licenses for en-route air traffic services; and flight centric, sector-less operations. The project also analysed the effects of unbundling the terminal control in Sweden, UK, Spain and Germany (mostly at regional airports). The models suggest that introducing competition in the market via outsourcing service provision may lead to a reduction in charges by up to half the current levels. They also show that open tendering is likely to lead to a defragmentation of the system, as companies tend to win more than one tender. The results suggest that with these options a maximum allowed market share of 40% could ensure sufficient competition. Competition of this nature will increase the uptake of new technologies and enable a high performing ATM system.

COCTA: Coordinated capacity and demand management in a redesigned Air Traffic Management value-chain

Radosav Jovanović, University of Belgrade

The coordinated capacity and demand management (COCTA) SESAR exploratory research project explores a novel approach to Demand-Capacity balancing for En-route Air Navigation Services. A Network Manager (NM) would specify optimum en-route capacity to be provided by each ANSP at strategic level and be able to adjust sector opening schemes at pre-tactical level within given limits. On the demand side, the NM would offer trajectory products to AOs with different margins left to NM to adjust their trajectories in time and space at differentiated prices. COCTA only addresses operational aspects and cost optimisation supposing fixed unit costs, not economic regulation and pricing aspects.

A mathematical model was developed to test this joint capacity and demand management process. The model aims at minimizing the sum of costs of capacity provision, delays and re-routings, by managing airspace sector configuration over time and trajectory assignments. A large-scale case study - covering eight ANSPs in Western and Central Europe – is used to evaluate the benefits of joint capacity and demand management decisions and to illustrate trade-offs between different performance indicators. The network performance achieved by COCTA under nominal conditions is compared against the results of a Baseline scenario.

Entry games for the airline industry

Christian Bontemps, Toulouse School of Economics / ENAC and Raquel Sampaio, Universidade Federal do Rio Grande do Norte

In this paper, we review the literature on static entry games and show how they can be used to estimate the market structure of the airline industry. The econometrics challenges are presented, in particular the problem of multiple equilibria and some solutions used in the literature are exposed. We also show how these models, either in the complete information setting or in the incomplete

information one, can be estimated from i.i.d. data on market presence and market characteristics. We illustrate it by estimating a static entry game with heterogeneous firms by Simulated Maximum Likelihood on European data for the year 2015.

An adjustable route charges mechanism

René Verbeek, NLR

Origin-Destination Charging makes the route charge to be paid by the airspace user independent from the planned route. The assumption is that this will remove the tendency of airspace users to choose detours to evade airspaces with relatively high unit rates. When not taking detours a reduction in fuel consumption, travel time and emissions is the result. Introducing a change to the charging mechanism is not easily taken as it influences billions worth of route charges. To ease the transition we propose a blended version of Origin-Destination Charging that can transition over time from Charging On Filed Route to Origin-Destination Charging.

Market power and volatility in the airline industry

Alexandra Belova, Philippe Gagnepain, and Stéphane Gauthier, Paris School of Economics

In a strategic game where firms compete against each other, the set of rationalizable strategies for each player entails all the best responses to the other's decisions. The theoretical literature has suggested that the uniqueness of the rationalizable outcomes coincides with the Nash equilibrium of the game. This paper proposes an empirical test of the existence of the uniqueness of the Nash equilibrium in a Cournot oligopoly. We focus on the U.S. airline industry and develop a theoretical model of competition on each route. It is assumed that airlines are not always able to predict perfectly the behavior of the competitors which can result in multiplicity of rationalizable outcomes. Based on the supply and demand ingredients of our model, we construct a stability criterion which guarantees uniqueness. We conclude that more than 90% of the local markets observed in the U.S. airline industry have reached the unique possible Nash equilibrium. As a by-product, we also identify the main determinants which prevent firms from reaching an equilibrium. We show in particular that local markets which include a higher number of competitors are the ones where the quantity produced is more volatile.

Passenger behavior and use of travel time in multimodal door-to-door travel experience

Nathalie Lenoir and Isabelle Laplace, ENAC

Today, new services and products open a realm of possibilities to the imagination of individuals, leading to profound changes in the way we live. These have an impact on travels, and on the use of travel time. However, until today, for practicality reasons, current transport models often consider individual transport modes with the primary attributes of monetary costs and time costs, using the value of time savings of travellers. This leads to the supremacy of speed in models of passenger behaviour and in the evaluation of transport infrastructure project although people now seem to value other attributes as much as price and time of travel. Moreover, they usually string together several transport modes from the origin to the destination. In this paper we look at previous research on various transport modes (or combination of transport modes) in order to identify the limits of the concept of value of time savings. The analysis of activities performed during a trip seems a fruitful avenue of research, validated by microeconomic theory, and leading to an emphasis on the quality of travel time in addition to duration.

A multi-layer model for assessing regulatory and business change

Gérald Gurtner, University of Westminster

This study presents a new holistic model for the air traffic management system built by the Vista project. The model is built to study the alignment and trade-offs of key performance indicators in the 2035 and 2050 horizons. It is based on three layers mimicking the long-term, mid-term, and short-term phases. It features massively multi-agents, highly data-driven, and very microscopic models. It is runnable as a what-if tool and has already been applied to different scenarios, including some featuring various level of support to the ATM support by the legislators. The results obtained with the model so far show various clear trends, including surging emissions, important reductions in delay uncertainty, and sizeable increases of buffers.

Conclusions and Debate

Availability of data for research

Air transport related data (radar tracks, flight plans, passenger flows, delays) is more readily available for the United States than for Europe. In consequence, many European research projects use US data instead of European data and produce results that cannot easily be generalized to Europe. The European air transport industry has an interest to make data available to benefit from 'free' research results. This topic has been discussed by ART on previous occasions and EUROCONTROL is putting measures in place that improve the availability of data.

The involvement of industry partners, notably airlines, in research projects is very desirable with a view to the availability of operational data for research.

The importance of data about preferences and behaviour of passengers is increasingly recognized.

Economic models

The workshop revealed that economics research is often using different models, tool and techniques than traditional ATM research. Whilst analytical approaches are more common in economics, ATM research often uses simulations based on micro-/meso-/ and macro-scale models. Different practices also exist to validate models with data-based approaches.

Acknowledging the existence of different scientific approaches and modelling techniques it could be interesting to engage in a discussion about their respective merits and shortcomings and how different approaches might complement each other.

Passenger-centred view

The passenger is increasingly recognized as the customer of the aviation system, not only by airlines.

The ACARE 4-hour door-to-door target has been established as a political objective to challenge the air transport industry and draw attention to the ultimate goal of improving mobility for citizens. However, a number of challenges remain, including

- the trade-off between mobility goals and the environmental impact and the question how the introduction of environmental constraints and taxes will change the behaviour of the passenger; also the need to advance environmental legislation so as to include NO_x and contrails;
- the impact that changes to regulations strengthening passenger rights, notably Flight Compensation Regulation 261, have on the behaviour of passengers and airlines alike; and
- changes in the preferences of passengers who may to some degree favour convenience and utility over shorter travel times – the 4-hour objective does not reflect this trade-off since the target is quantified in time only without considering the utility of travel time.

A passenger-centred view and understanding of the air transport system is very desirable so as to complement the aircraft/airspace-centred view the industry has traditionally taken. Data must be collected and models must be developed that support such a passenger-centred view.

The fact that ATFM delay is defined as departure delay rather than arrival delay (which might be more meaningful for the passenger) reflect the current aircraft- and operations-centred rather than passenger-centred view.

The passenger should not only be understood but also informed and involved in the execution of his trip, e.g. by providing real-time information about flight and connection status and rebooking options in case of delays.

Collaboration between ATM stakeholders

It would be desirable for ATM research to better understand airline business and priorities. For example, air traffic management is only one amongst many factors to consider during airline planning and operations. Ideally, we would manage to involve airlines in research project as consortium member.

Collaboration between all actors and consequently data sharing at network level is necessary to provide real service improvements to passengers. This concerns data sharing for research purposes but also operational data sharing.

Involving all actors in the system would be desirable from an efficiency point of view: in order to protect themselves from uncertainty each individual actor (airline, ANSP, airport, network manager plus other service providers) adds a buffer; this leads to inefficiency and wasted capacity. Since uncertainty can at least partly be removed and better managed by sharing information, efficiency gains can be expected from collaborating.

Swiss and KLM were mentioned as airlines interested in taking and advancing a passenger-centred view.

Informing policy makers

Research could contribute to discussions on political and institutional level, not only in ACARE, the Challenges to Growth report and in the context of regulation 261. Two examples were mentioned:

- The recently published '[Wise Persons Group Report](#)' which has ten recommendations to improve The Single European Sky. Some of these recommendations include economic regulation, in particular the recommendation to 'establish a strong, independent and technically competent economic regulator at European level.' Research can help to understand economic regulation in the context of SES and make recommendations about its implementation.
- The '[Airspace Architecture Study](#)' could benefit from research-based recommendations, e.g. about how to best balance airspace capacity between ACCs or even ANSPs

List of Participants

| Last name | First name | Organisation |
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