



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



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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



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Outline of talk

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



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



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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



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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)



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Outline of talk

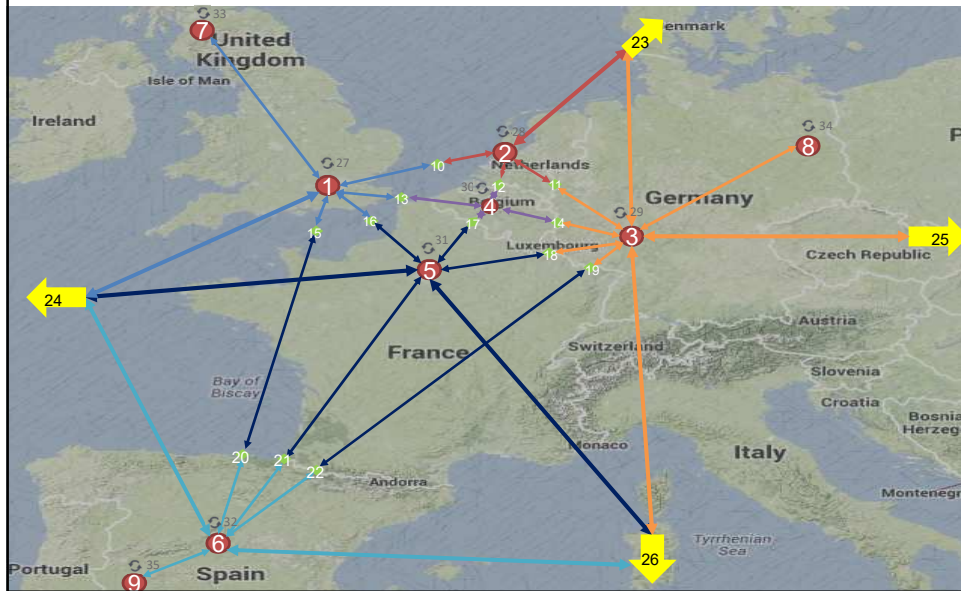
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Case Study of Western Europe



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)



Results: no tender (1/6)



Business as usual	Price in € per peak / off-peak per km						Labour	Tech	Revenues	Profits
	UK	Netherlands	Germany	Belgium	France	Spain		level	(000 €)	(000 €)
ANSPs										
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
ENAI						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	Revenues	Profits
	UK	Netherlands	Germany	Belgium	France	Spain		level	(000 €)	(000 €)
ANSPs										
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
ENAI						0.86	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...

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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
ENAI	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%



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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
ENAI	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%



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Results: with tender (4/6)

For Profit ATC providers with 'global growth'



For-profit	Price in € per peak / off-peak per seat per km						Labour	Tech level	Revenues (000 €)	Profits (000 €)
	UK	Netherlands	Germany	Belgium	France	Spain				
Global 2050 ANSPs										
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



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Results: with tender Impact on Airlines



Airlines	User Equilibrium business as usual			Profit Maximization under auctions			Profit Maximization under auctions global demand 2035		
	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



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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

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Results: without tender (6/6)

Non-profit ATC providers



Non profit No tender ANSPs	Price in € per peak / off-peak per km						Labour	Tech level	Revenues (000 €)	Profits (000 €)
	UK	Netherlands	Germany	Belgium	France	Spain				
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)
ENAI						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



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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



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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



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Air traffic control:
encouraging technology adoption & overcoming weak regulation

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