



The uptake of new technologies in air traffic management

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Introduction



Air transport industry is facing host of new challenges:

- Strong competition
- Increase demand
- New restrictions related to climate change

- SESAR Joint Undertaking -> improve European's aviation infrastructure using new technologies that automate, virtualize and enhance digital connectivity in air traffic management (ATM).

- Results have not live up to expectation: in 2018 Court of Auditors
 - Only 23% of projects completed, 13% not yet planned
 - ANSP (Air Navigation Service Provider) investments were 25% lower than planned

WHY?

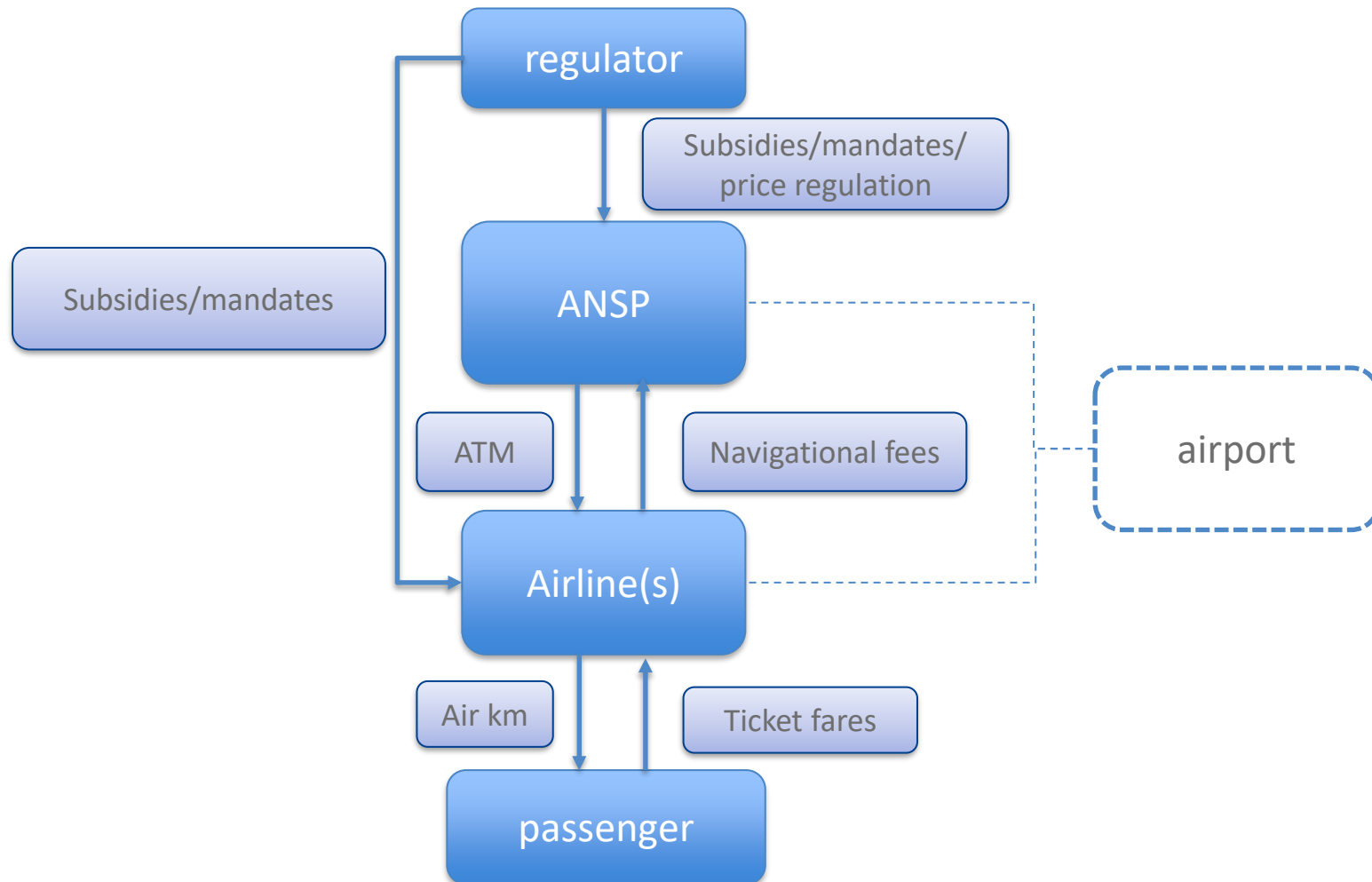
Potential reasons for low uptake

- Fragmentation: EU has 37 national ANSPs -> compatibility and cooperation problems
- Home bias
- Strong labour unions
- Geographic monopoly: prices, market power
- Demanding safety requirements

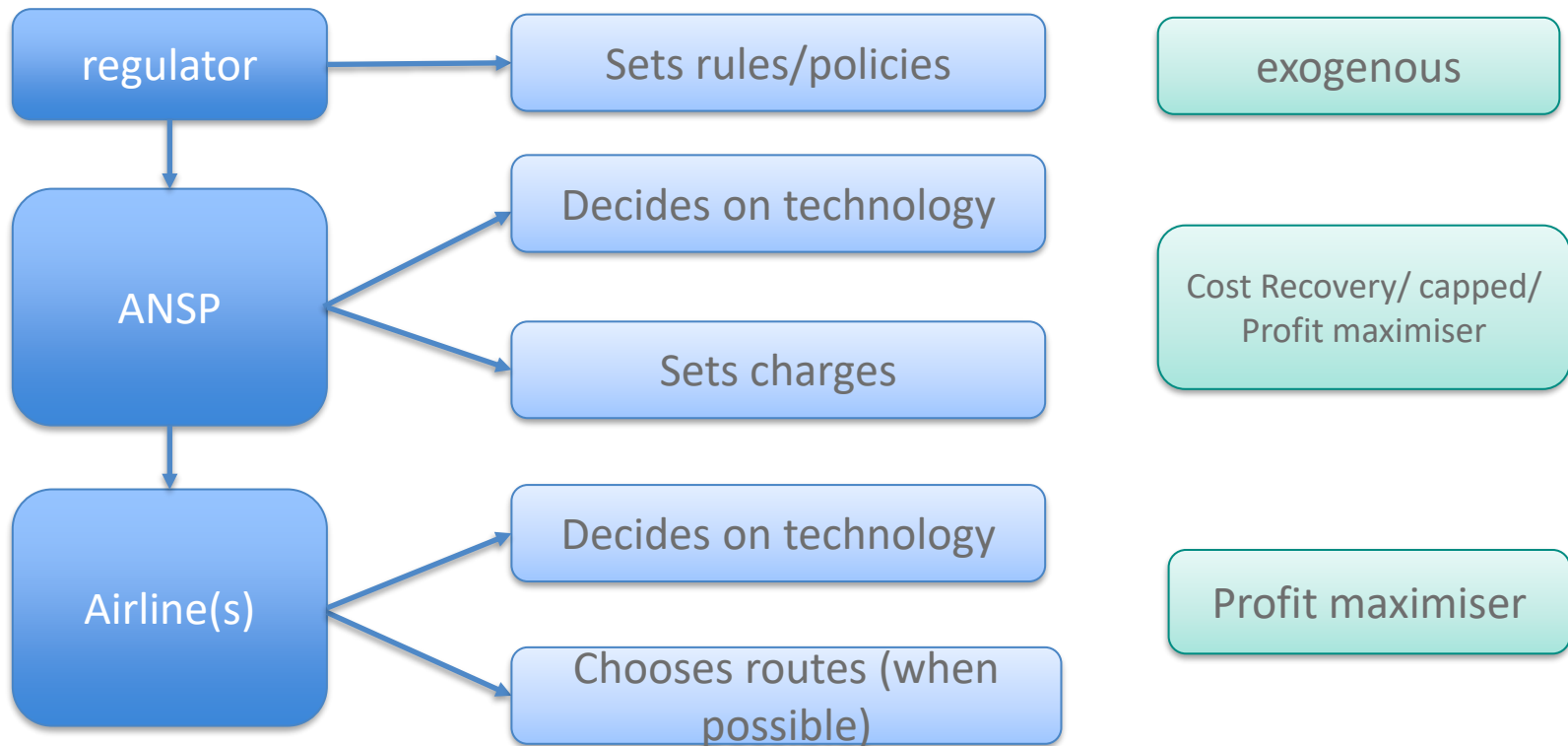
This work focuses on issues due to the **nature of the technologies** itself:

- Network characteristics: full benefits only realised when substantial part of the whole network is upgraded
- Split-incentives: Both the ANSP and airline need to invest but benefits mainly for the airlines while most of the investment cost costs are born by the ANSP

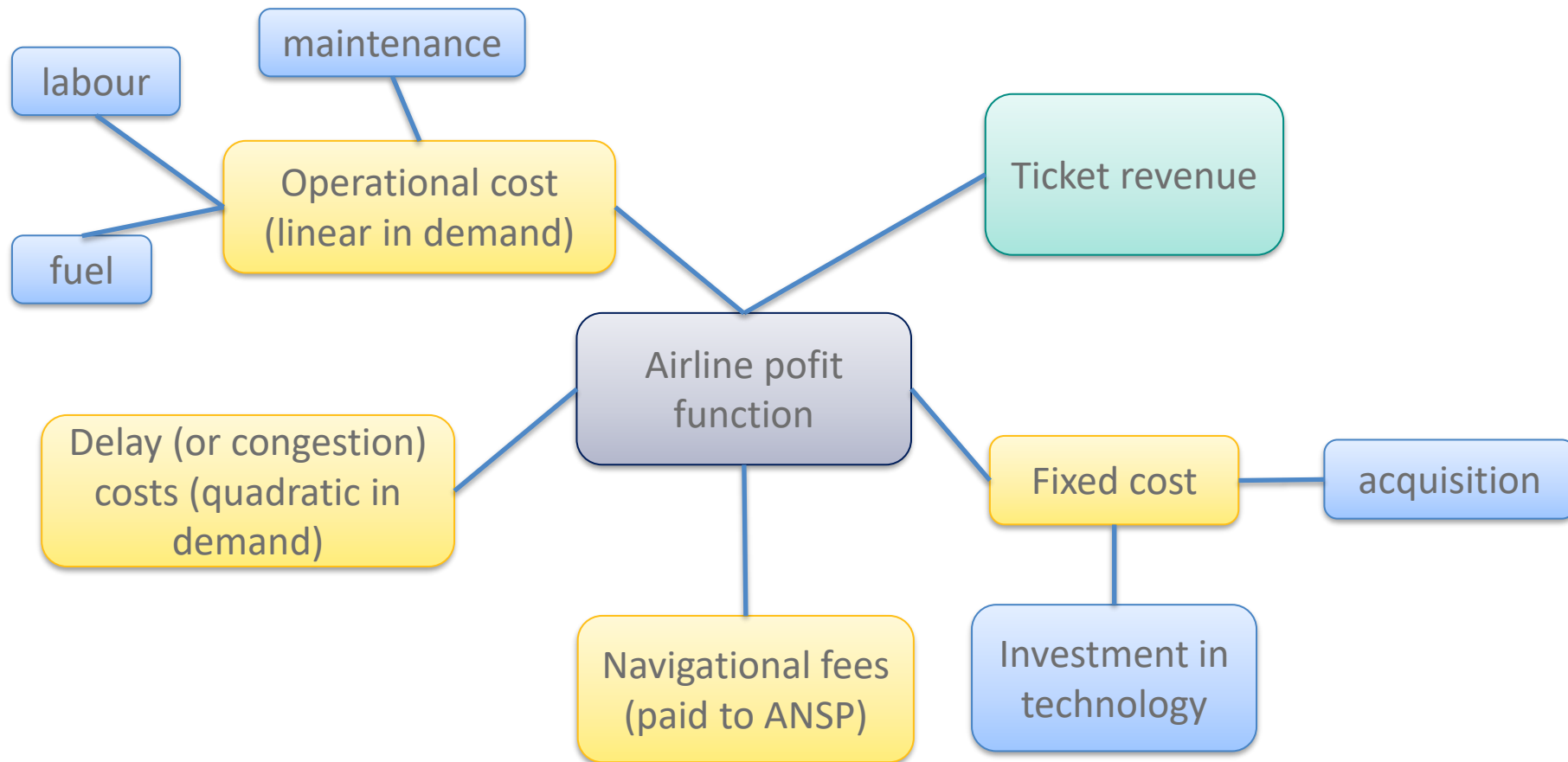
Economic model: Agents



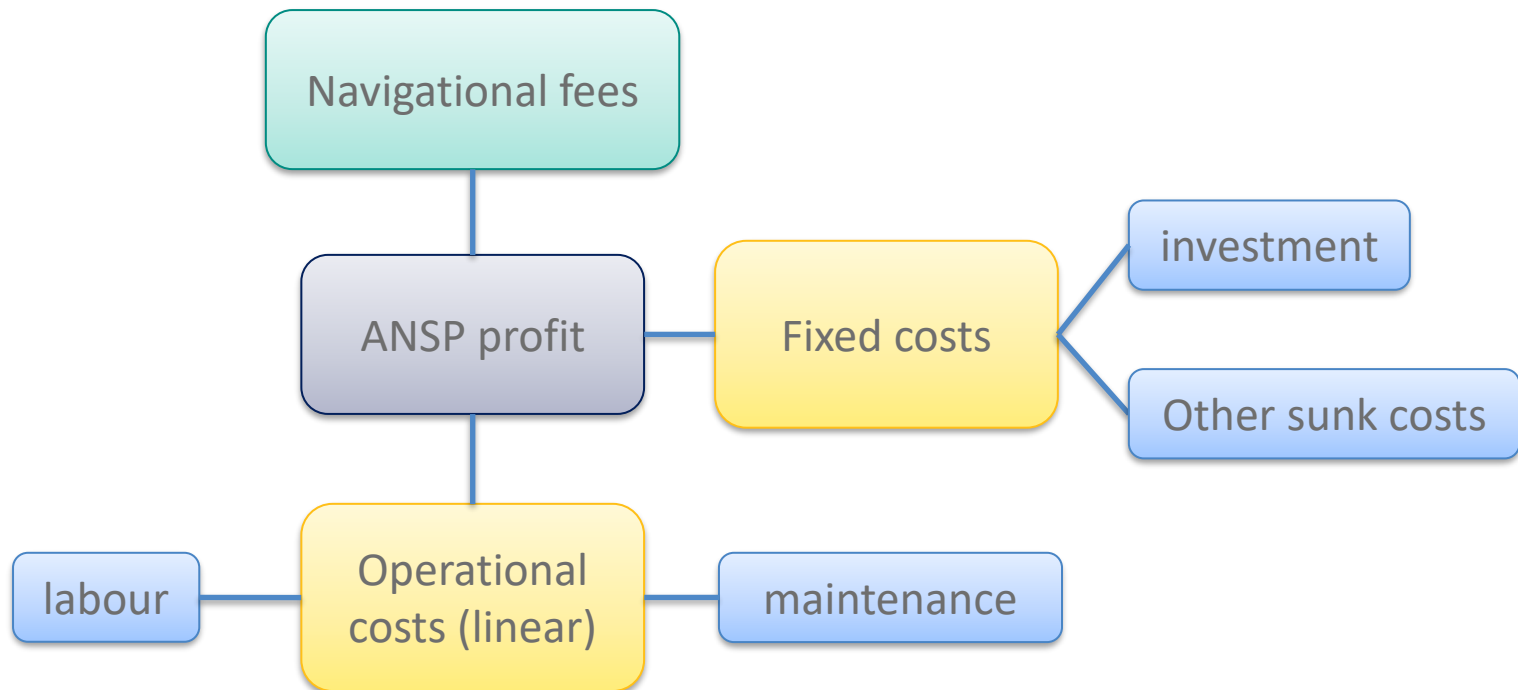
Two stage game



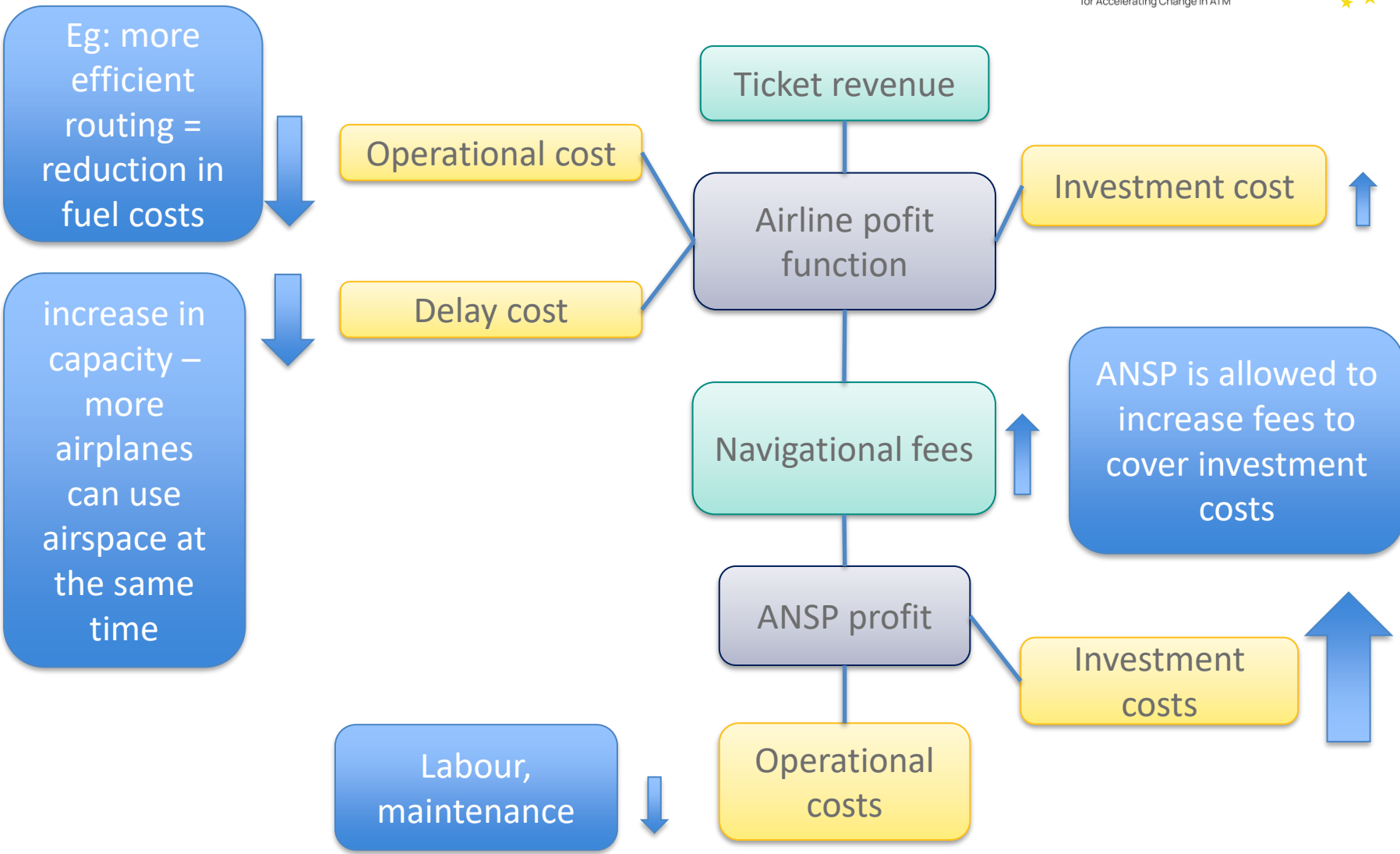
Profit functions: Airlines



Profit functions: ANSP



New technology



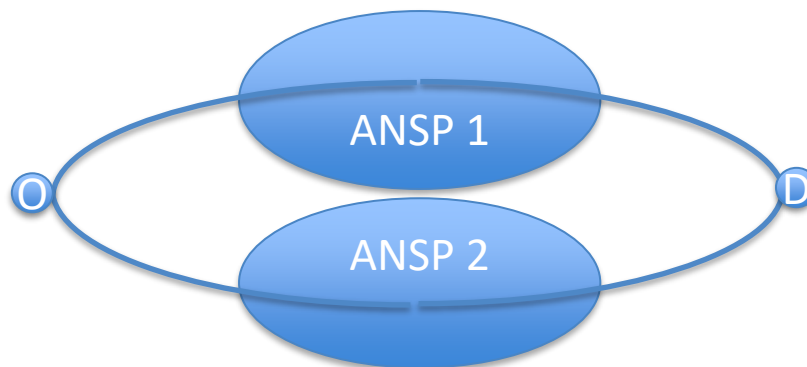
Networks

- One ANSP – eg US airspace: Monopoly vs duopoly

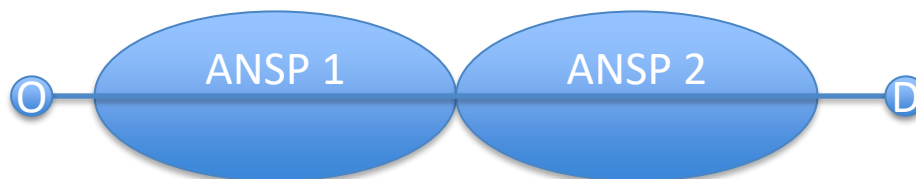


- EU much more complex: start with simple networks

- Parallel



- Serial



The simplest setting: one ANSP and one airline

Invest?	AIR/ANSP	REF (Meuro)	YES/NO (%)	NO/YES (%)	YES/YES (%)
Airline	Demand	1 832 780	0.0	-0.2	8.9
	Revenues	194 349	0.0	-0.1	4.1
	Variable Cost	93 105	0.0	0.2	-10.7
	Delay cost	2 073	0.0	-0.4	-5.1
	Profits	42 035	-1.4	-0.9	41.4
ANSP	Revenues	7 332	0.0	4.8	14.4
	Variable Cost	5 498	0.0	-0.2	-2.0
	Profits	599	0.0	39.9	173.3
	Welfare	285 522	-0.2	-0.2	12.4

- if the ANSP can ask a higher charge (capped), it will have an incentive to adopt the new technology
- If the ANSP invests, the airline would be willing to invest

Findings:

- No need for policy on airline side
- allowing the ANSP to be able to charge above costs recovery charge
- If not feasible – subsidies/mandate or combination

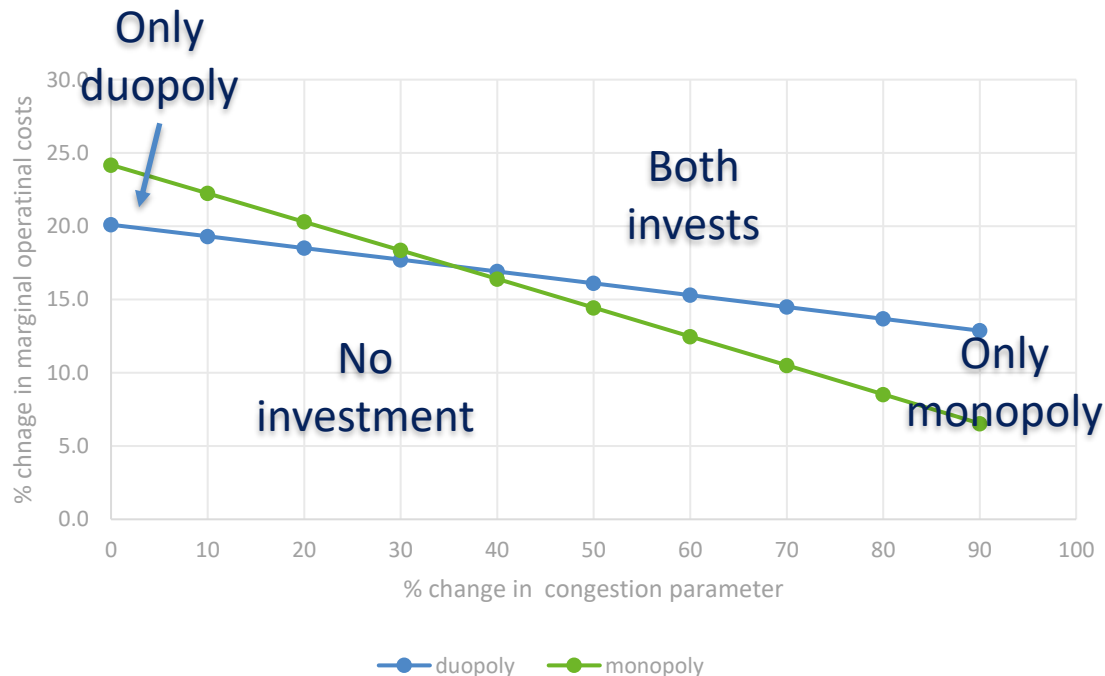
One ANSP, airline duopoly (symmetric)

Invest?	Air_A/Air_B/ANSP	N/N/N (Meuro)	Y/N/Y (%)	N/N/Y (%)	Y/Y/Y (%)
Airline A	Demand	1 224 111	17.3	-0.2	8.9
	Revenues	108 024	13.2	0.0	1.1
	Variable Cost	61 940	-3.9	0.2	-10.8
	Delay cost	1 849	10.2	-0.4	-5.1
	Profits	15 627	104.0	-1.0	49.5
Airline B	Demand	1 224 110	-8.6	-0.2	8.9
	Revenues	108 024	-11.8	0.0	1.1
	Variable Cost	61 940	-8.3	0.2	-10.8
	Delay cost	1 849	-14.2	-0.4	-5.1
	Profits	15 627	-47.2	-1.0	49.5
ANSP	Revenues	9 304	9.6	4.8	14.4
	Variable Cost	7 345	-1.5	-0.2	-2.0
	Profits	725	121.2	46.6	187.3
	Welfare	377 962	5.9	-0.1	11.5

- If competitor invests it's better to invest too
- A lot depends on the impact of the technology on the operating costs and delay costs

Monopoly vs duopoly

For different impacts on the congestion of the technology, compute the corresponding operational reduction needed for airline A to break even if it invests in the new technology:



Findings:

- In a duopoly, airlines do not take full impact of congestion from technology, only the impact on own market
- Uptake of technologies with strong network effects could be hindered by more competitive market

One ANSP, LC (low cost) vs LCC (legacy carrier)

	Legacy carrier	Low cost
Operational cost vs delay cost reduction	Behaves more monopolistic -> responds more to tech. that enhanced capacity	Lower profit margin -> responds more to tech. that enhanced efficiency
Navigational fee	Nav fees less important -> more responsive to policies that give priority (better service) to equipped aircrafts	More responsive to navigational fees -> more responsive to policies that give monetary reduction to equipped aircrafts

Parallel network

- ANSP point of view: first mover advantage
- Airlines point of view:
 - One airline:
 - If only one ANSP invests: benefits of the technology could be watered down if congestion costs from increase use of the investing ANSP forces the airline to still use the other ANSP
 - Duopoly:
 - further dilution of benefits for investing airline as non-investing airline will use non-investing ANSP (to avoid increased navigational charges) increasing congestion on this corridor
 - However: increase in market share of investing airline can dominate

Parallel network: airline duopoly

Invest?	Air_A/Air_B/ANSP_M /ANSP_N	N/N/N/N (Meuro)	Y/N/Y/N (%)	Y/Y/Y/N (%)	Y/Y/Y/Y (%)
Airline A	Demand	1 221 879	15.2	7.1	8.9
	Revenues	107 988	11.7	1.0	1.2
	Variable Cost	62 071	-5.6	-12.2	-10.7
	Delay cost	1 843	37.9	83.5	-5.1
	Profits	15 466	97.6	44.3	49.8
Airline B	Demand	1 221 878	-7.6	7.1	8.9
	Revenues	107 988	-10.4	1.0	1.2
	Variable Cost	62 071	-7.5	-12.2	-10.7
	Delay cost	1 843	-23.0	83.5	-5.1
	Profits	15 466	-39.7	44.3	49.8
ANSP M	Demand	1 222 212	33.1	114.2	8.9
	Revenues	4 889	39.7	124.9	14.4
	Variable Cost	3 667	21.5	92.8	-2.0
	Delay	1 844	59.3	267.0	-5.1
	Profits	605	180.1	436.7	117.8
ANSP N	Demand	1 222 545	-25.4	-99.9	8.9
	Revenues	4 890	-25.4	-99.9	14.4
	Variable Cost	3 665	-25.5	-100.0	-2.0
	Delay	1 845	-44.4	-100.0	-5.1
	Profits	609	-51.1	-200.7	117.1
	Welfare	377 577	5.5	9.6	11.5

- the ANSP can increase its profits substantially by adopting the technology and risks to lose up to half of its profits if it doesn't, but its competitor does
- Increase in market share for investing airline compensates -> shifts entire demand to investing ANSP
- Similar results as one ANSP

Serial network, airline duopoly

Invest?	Air_A/Air_B/ANSP_M /ANSP_N	N/N/N/N (Meuro)	Y/N/Y/N (%)	Y/Y/Y/N (%)	Y/Y/Y/Y (%)
Airline A	Demand	1 176 685	17.9	9.0	18.1
	Revenues	107 064	14.0	1.7	2.1
	Variable Cost	64 482	-1.8	-9.2	-21.4
	Delay cost	1 709	16.9	7.0	11.5
	Profits	12 266	127.1	59.7	127.1
Airline B	Demand	1 176 687	-9.1	9.0	18.1
	Revenues	107 065	-12.1	1.7	2.1
	Variable Cost	64 482	-8.7	-9.2	-21.4
	Delay cost	1 709	-9.8	7.0	11.5
	Profits	12 266	-58.0	59.7	127.1
ANSP M	Demand	2 353 372	4.4	9.0	18.1
	Revenues	9 413	9.6	14.5	24.0
	Variable Cost	7 060	-7.4	-12.8	-5.5
	Delay	1 709	-1.9	-4.9	11.5
	Profits	1 736	78.7	126.9	149.0
ANSP N	Demand	2 353 372	4.4	9.0	18.1
	Revenues	9 413	4.4	9.0	24.0
	Variable Cost	7 060	4.4	9.0	-5.5
	Delay	1 709	9.0	18.8	11.5
	Profits	1 736	6.0	12.2	149.0
	Welfare	362 197	6.1	11.9	24.4

- airlines have again a greater incentive to adopt the technology as they cannot divert their traffic
- a free riding problem may occur in such a setting; the ANSP that doesn't adopt the technology, will still profit from the investment of the other ANSP

Take away messages

- Regulation of navigational fees = necessary
- increased competition between airlines can reduce incentives to adopt technologies especially for technologies that impact delay costs
- **Parallel network:** Increased competition between ANSP
 - **First mover advantage** for ANSP, especially with a lot of transit (captive) traffic.
 - Incentives for the **airlines reduced** (in some settings)
 - Technologies with no or little costs/benefits for airlines: free riding problem for ANSPs
- **Serial network:** ANSP can free ride on investment of others – reduces adoption likelihood of ANSPs
- mandates can be welfare improving in a fractured and competitive market such as the European airspace



Thank you



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