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“Nash equilibrium” situations among ATM
Service Providers in Functional Airspace
Blocks. A theoretical study.

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- Subject of the study & its importance;
- What has been done so far in this area;
- What the study contributed;
- A short study case: the BLUE MED FAB;
- Conclusions & suggestions for further work;

Subject & its importance

- Markets reach equilibriums with short or longer life;
- Will FABs end soon or later to equilibriums and of what kind?
- Analysing this gives advance hints whether expected benefits will be timely delivered at affordable cost;
- Enables proactive regulative action as ATS presents considerable inertia;
- Introduces a novel approach on FABs/ATS economics.

What has been done so far:

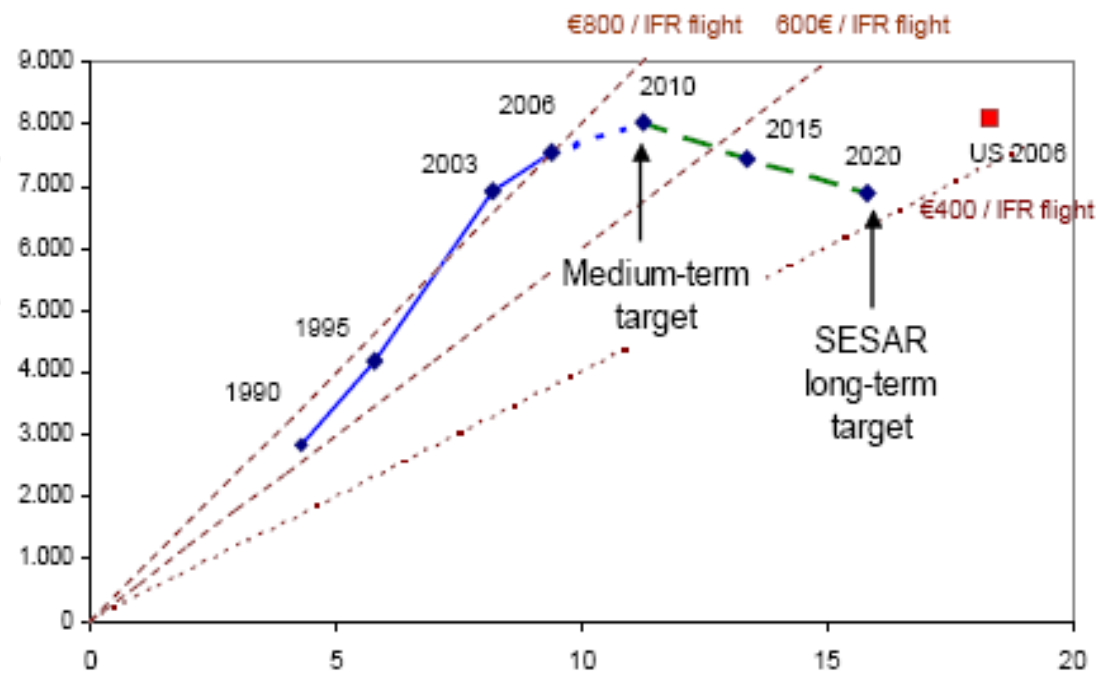
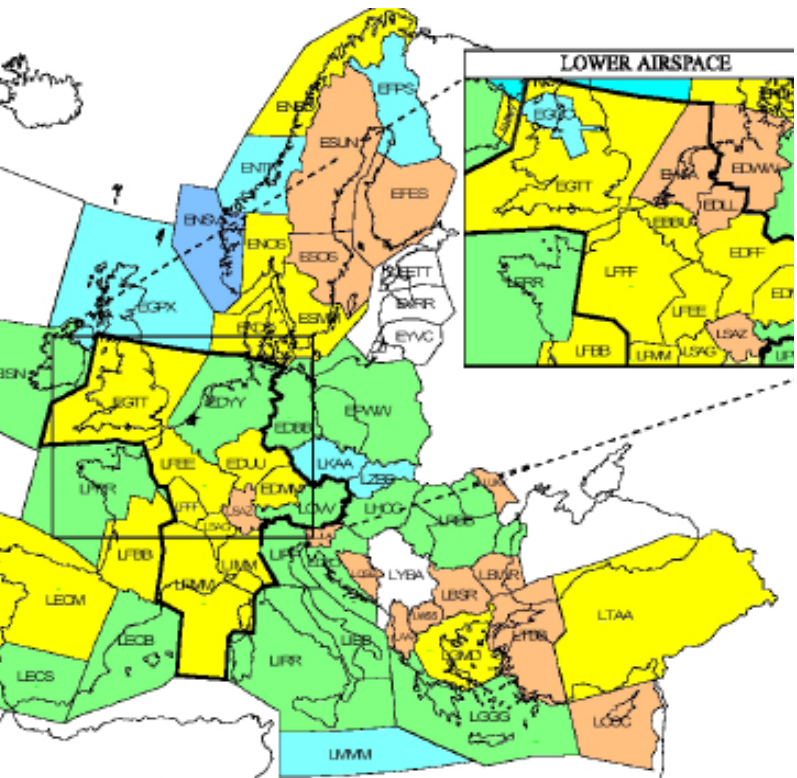
- Rich literature in pure economics and game theory;
- No particular work on the specific subject;

Contribution of the study:

- Proposed Cournot, Bertrand & Nash Equilibriums models for the case of FABs ;
- Build up a set of definitions as to have a study framework system;
- Introduced a two-fold hypothesis for the developments in the FABs and;
- The notion of Airspace Elasticity;
- Went briefly into a study case;
- Deducted that NE is the most probable equilibrium.

What's all about:

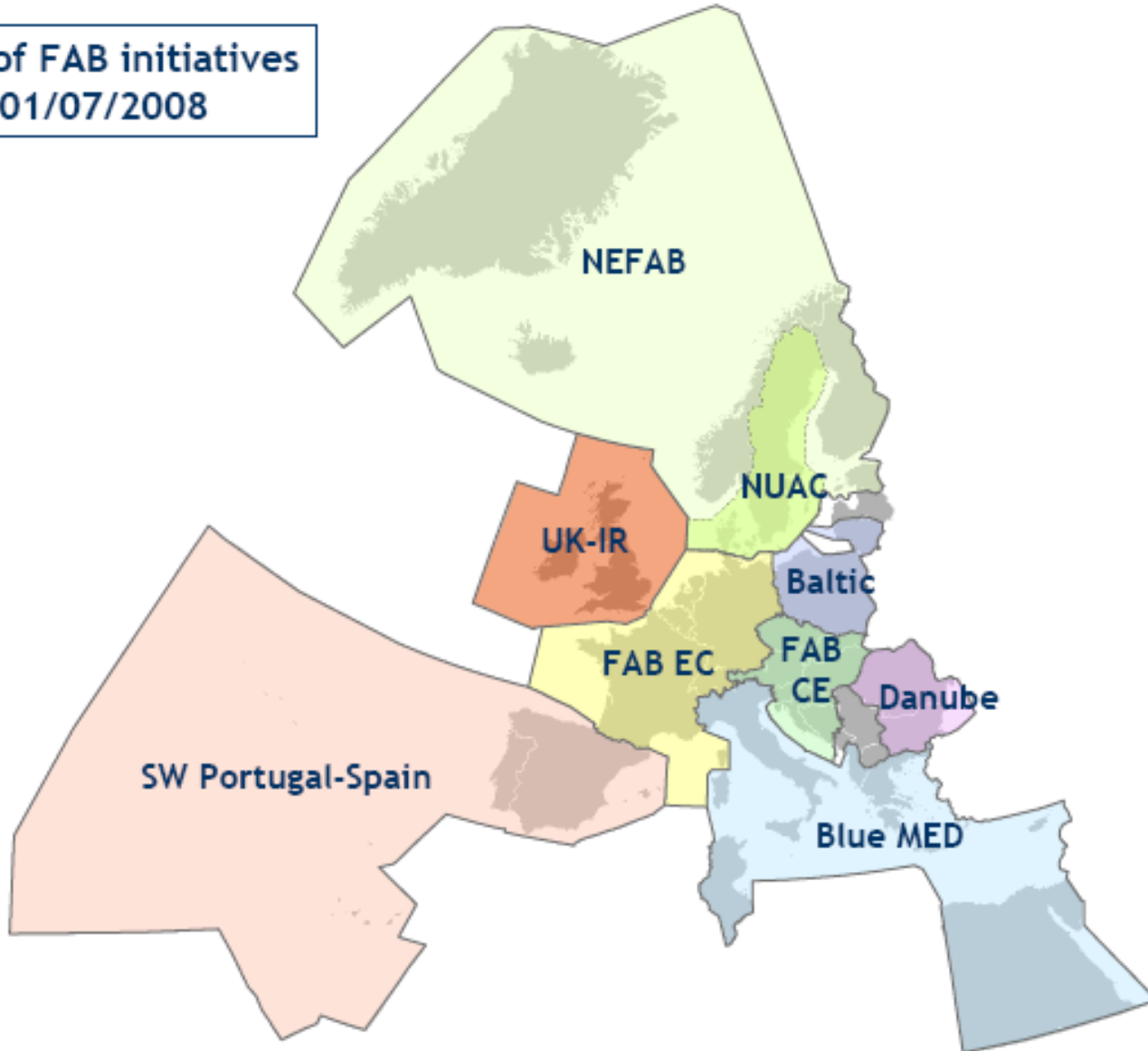
- A fragmented, under-performing ANS system?



A "vision" of things to come...

FABs implemented or under development:

Map of FAB initiatives
01/07/2008



- About the ANS & more specifically about the ATS economics:
 - ATS “natural monopoly” (and by regulation...)
 - Supply=offered capacity in a given airspace in service units to airspace users/year;
 - Demand=required service units/year;
 - Price=actual unit price as per CRCO actual Unit Cost i.e total rec. cost/total service units;
 - Supply and demand assumed generally linear except in cases of elasticity measurements;

ATS Economics: Supply, Demand, Price & Elasticity characteristics:

- Nearly zero marginal cost; high % of fixed cost (supply curve with small gradient i.e. considerable inherent cost even without output).

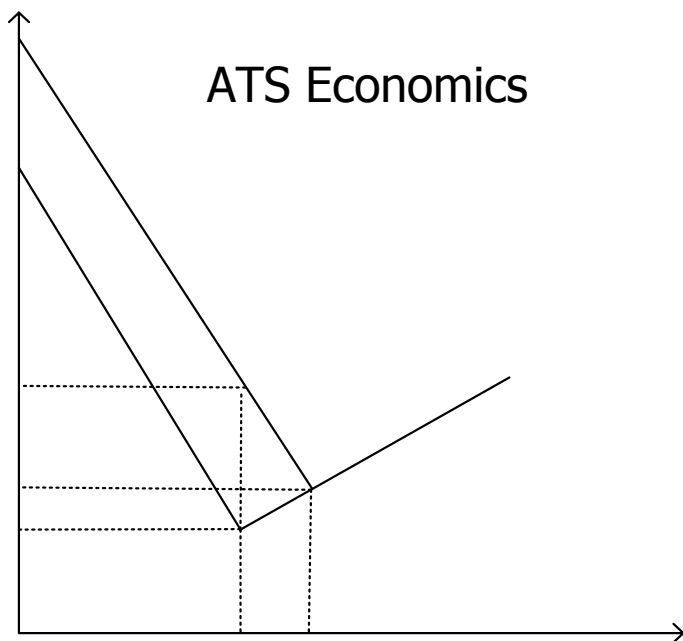


Fig. 3: Price-demand behaviour of ATS provision in linearly changing demand conditions and at the limits of capacity supply (service units)

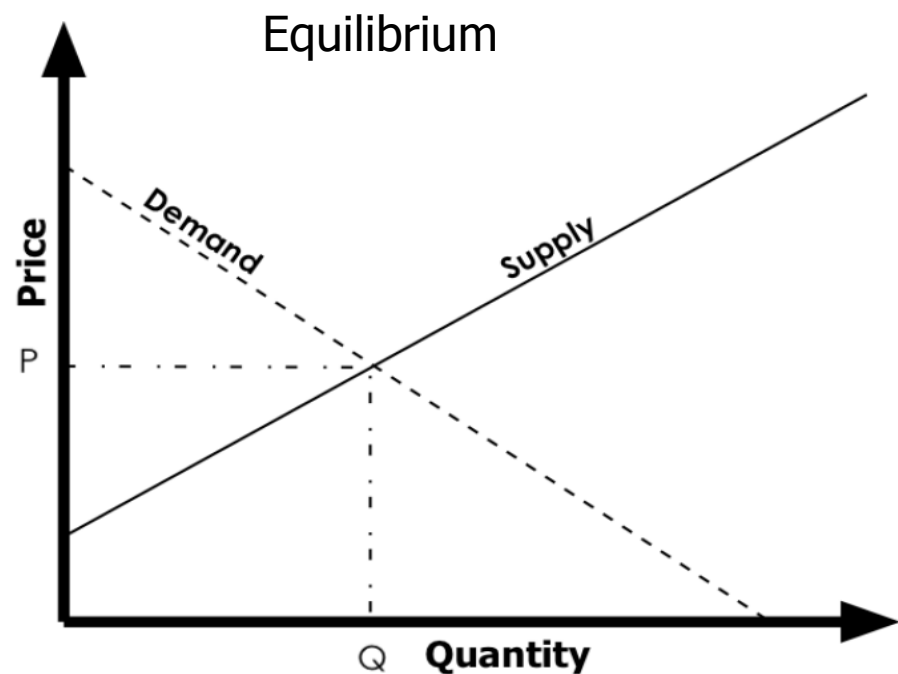


Fig. 7: Economic equilibrium in a FAB. The demand for Service Units (Q) is met by offered Capacity (Supply) in an acceptable unit price P (unit rate).

ATS Economics:

Introducing the Elasticity of Airspace.



- An airspace is elastic ($\Delta Q/Q_2/\Delta P/P_2 > 1$) when changes in unit price cause opposite changes in demand i.e. decreasing unit price increase demand and vice versa (until supply/capacity limits are reached).

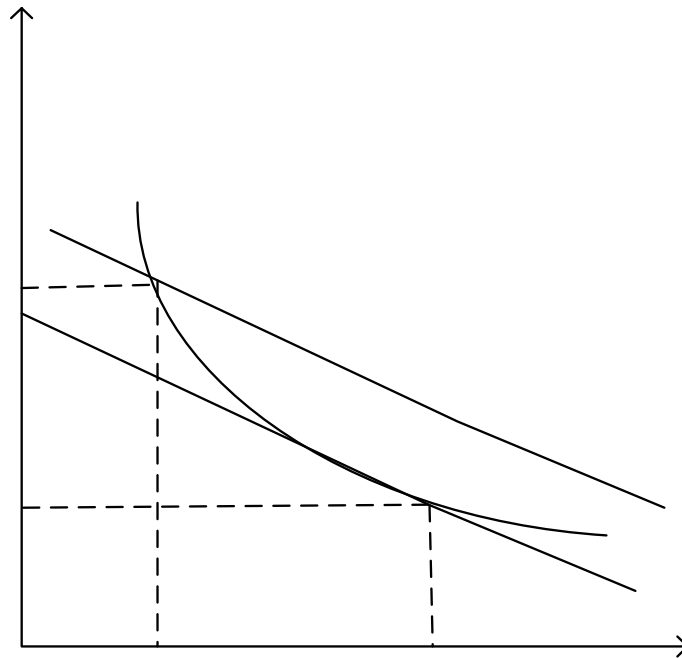


Fig. 8: Airspace elasticity: ATSPs operating at point E' of the price/demand curve are rather inelastic regarding price elasticity of demand due to their airspace geographical properties (inelastic airspace). Operating at point E has the opposite effect i.e. small relative variations of price cause large variations in demand (high elasticity).

Important hypothesis:

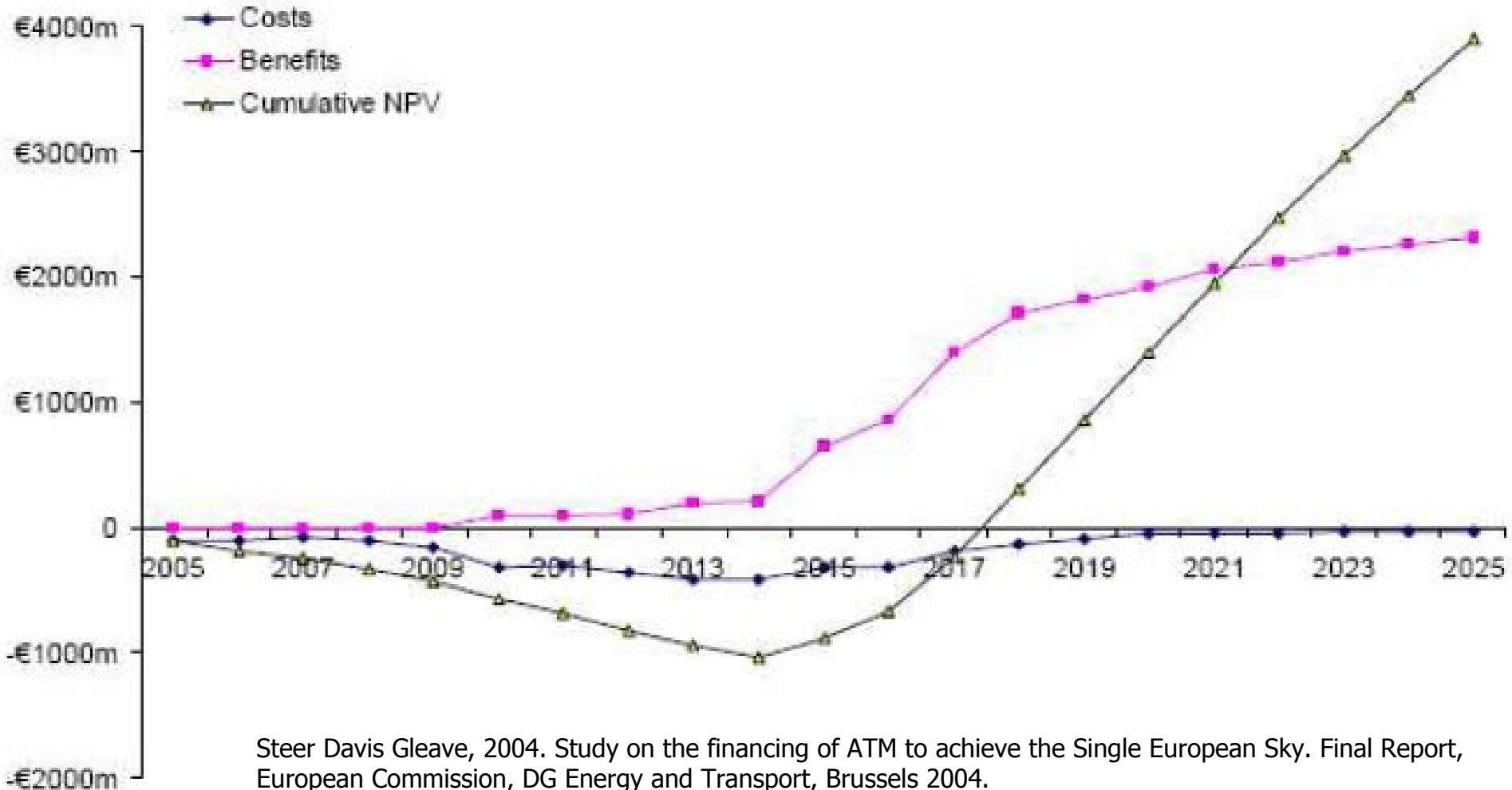
- “FABs will contain more than one ANSP and many charging areas”
 - Corollary: Performance & benefits will be mostly generated in the “flight efficiency” domain:

	2013 benefits in M€	2013 benefits as % of 2006 total economic costs	<i>% from flight efficiency or delay</i>	2018 benefits in M€	2018 benefits as % of 2006 total economic costs	<i>% from flight efficiency or delay</i>
Blue Med	14 – 49	1 – 5%		14 – 71	2 – 7%	
Danube *	29 – 52	12 – 22%	99%	29 – 52	12 – 22%	99%
FAB CE	6	1%	53%	21 – 30	4 – 6%	55%
FAB EC	260	8%	77%	1150	36%	83%
NUAC	47	17%	72%	51	18%	81%
UK-Ireland	12	1%	100%	40	4%	63%

*: Assumptions and expert judgements would need to be confirmed.

Cost of FABs vs. benefits:

- CBA: Costs/Benefits will not break even before 2018



- Competition and/or “coopetition” will not be the drive for increasing performance;
- Situation to settle within the FAB (“equilibrium”)
- What are the possibilities:
 - Cournot Equilibrium (CE)
 - Bertrand Equilibrium (BE) and
 - Nash Equilibrium (NE)
- We argue NE would be the most probable (best fit) settlement.

■ Reasons for excluding CE:

- ATSPs will not collude within FABs; They have all data;
- They plan as to achieve certain capacity in a given time, but this is done at central pan-European level and not as a result of their one strategy;
- Known to all capacity targets for the next 5 years;
- Cannot settle on a quantity/capacity that maximises revenues; instead are obliged to respond proactively to demand.

■ Reasons for excluding BE:

- Cannot settle on prices that maximize revenues;
- High % of fixed cost;
- Full cost recovery or price-cap regulation, overall regulated prices.

Why NE is the most probable scenario:

- ATSPs' strategy in a FAB is a complex set of many variables i.e. Price, Quantity and Supply, other (and not only quantity or only price as per CE and BE);
- Impractical to alter/direct demand to one's favour by price adjustment;
- ATSPs aware of the strategy of the others in the FAB; targets set/published at pan-European level;
- Also know that other ATSPs in the FAB are fully informed of any change they plan to implement;
- Altering quantities and prices, provide no benefits in the medium/long-term;
- ATSPs in a FAB have nothing to gain but to loose by changing own strategy unilaterally while others keep theirs unchanged.

Study case:

- A FAB under the magnifying glass:

Table 5: Comparative data analysis of the ATSPs/ANSPs participating in the BLUE MED FAB.

State/ATSP	Chargeable Base Cost 2008 in €	Actual service units 2008	Actual unit price 2008	% of total base cost	% of total SUs	%SU/%TBC FAB Cost efficiency
Albania/NATA	15.585.077	324.951	47,96	1,87	2,17	1,16
Cyprus/DCA	40.892.722	1.310.890	31,19	4,90	8,75	1,79
Greece/HCAA	174.888.560	4.258.001	41,07	20,94	28,43	1,36
Italy/ENAV	593.672.357	8.660.349	68,55	71,09	57,83	0,81
Malta/MATS	10.069.836	421.760	23,88	1,21	2,82	2,34
Total	835.108.552	14.975.951	55,76 ⁹	100,00	100,00	

- A NE can be settled towards lower performance (unless performance is effectively regulated)!
- The case is supported by isomorphic tendencies & the quest for legitimacy.

Conclusions & further work:

- Setting a framework for ATS economics in FABs;
- Introduced Elasticity of airspace;
- Examined three possible models of equilibriums;
- Concluded that Nash Equilibrium is most fit to explain, interpret and foresee economic phenomena among ATSPs in FABs;
- Further specific to target regulation is needed to prevent equilibriums of sub-optimum performance in FABs;
- Isomorphism may add to this;
- Other or all FABS could/should be analysed in more depth while "NE Equilibriums" can be modeled and simulated.

