Analysis of the evolution of cost-effectiveness in the provision of air navigation services at Functional Air Blocks

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Overview

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- In this analysis we analyse the provision of air navigation services **at FAB level** and decomposing the evolution of cost-effectiveness into **seven driving forces**.

- Assume the following **equation for the *i*–th ANSP ATM/CNS provision costs**:

$$C_i = C\left(Y_i, W_i, Z_i, K_i, t\right)/E_i$$

where:

Y_i	the number of flight hours controlled
W_i	a vector of input prices
Z_i	a vector of observable environmental variables
t	a time trend (technical change + exogenous temporal effects)
K_t	a measure of capital
$E_t \leq 1$	a measure of cost–efficiency

Cost–effectiveness

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- The **aggregate rate of growth** of the cost–effectiveness of the FAB ($\dot{AC}$) can be decomposed as follows:

$$\dot{AC} = \dot{C} - \dot{Y} = \sum_{i=1}^{N} p_i \dot{C}_i - \sum_{i=1}^{N} s_i \dot{Y}_i$$

where:

p_i	share of the i–th ANSP in total provision cost
s_i	share of the i–th ANSP in total controlled traffic hours

Decomposition

- $\dot{C}_i$ can be **further decomposed** as:

$$\dot{C}_i = (\varepsilon_{CYi} - 1)\,\dot{Y}_i + \varepsilon_{CKi}\dot{K}_i + \varepsilon_{CWi}\dot{W}_i + \varepsilon_{CZi}\dot{Z}_i + \varepsilon_{Cti} - \dot{E}_i + \dot{Y}_i$$

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- If we **combine the previous two equations** we obtain:

$$\dot{AC} = \sum_{i=1}^{N} p_i\,(\varepsilon_{CYi} - 1)\,\dot{Y}_i + \sum_{i=1}^{N} p_i\varepsilon_{CKi}\dot{K}_i + \sum_{i=1}^{N} p_i\varepsilon_{CWi}\dot{W}_i + \sum_{i=1}^{N} p_i\varepsilon_{CZi}\dot{Z}_i + \sum_{i=1}^{N} p_i\varepsilon_{Cti} - \sum_{i=1}^{N} p_i\dot{E}_i + \sum_{i=1}^{N} (p_i - s_i)\,\dot{Y}_i$$

Seven sub–effects

- Therefore, the variation in cost–effectiveness can be decomposed in the following **sub–effects**:

$$\dot{AC} = SE + KE + IPE + ZE + TCE + ECE + RE$$

Effect	**Formula**
Scale effect (SE)	$\sum_{i=1}^{N} p_i \left(\varepsilon_{CYi} - 1 \right) \dot{Y}_i$
Capital effect (KE)	$\sum_{i=1}^{N} p_i \varepsilon_{CKi} \dot{K}_i$
Input price effect (IPE)	$\sum_{i=1}^{N} p_i \varepsilon_{CWi} \dot{W}_i$
Environmental factor effect (ZE)	$\sum_{i=1}^{N} p_i \varepsilon_{CZi} \dot{Z}_i$
Technical change effect (TCE)	$\sum_{i=1}^{N} p_i \varepsilon_{Cti}$
Efficiency change effect (ECE)	$-\sum_{i=1}^{N} p_i \dot{E}_i$
Redistribution effect (RE)	$\sum_{i=1}^{N} \left(p_i - s_i \right) \dot{Y}_i$

Estimation

- The **econometric specification of the cost equation** can be written as:

$$lnC_{it} = \alpha_{FAB} + \alpha_t + TL\left(Y_{it}, W_{it}, K_{it}, \beta\right) + \gamma Z_{it} + v_{it} + u_{it}$$

where:

α_{FAB}	time-invariant cost drivers at FAB level
α_t	effect of time–varying exogenous factors
TL	Translog function
β	vector of technological parameters
γ	effect of observable environmental variables
v_{it}	noise term
$u_{it} = -lnE_i \geq 0$	random term capturing the inefficiency of ANSPs

Data sources

Variable	Description	Unit	Source
C	(financial) ATM/CNS provision costs	'000 euro 2016	EUROCONTROL
Y	Composite flight hours controlled	hours	EUROCONTROL
K	Net book value of fixed assets in operation	'000 euro 2016	EUROCONTROL
$ATCOh$	ATCOs in OPS hours on duty	hours	EUROCONTROL
W_1	Price of ATCOh	euro 2016/h	EUROCONTROL
W_2	Price of non–ATCO staff	'000 euro 2016	EUROCONTROL
W_3	Price of non–staff operating inputs	Producer Price Index	EUROSTAT
W_4	Capital related input price	index	EUROCONTROL/EUROSTAT
Z_1	Size of airspace controlled	km^2	EUROCONTROL
Z_2	Structural traffic complexity	Composite index	EUROCONTROL
Z_3	Traffic variability	peak/average week	EUROCONTROL

Summary statistics

Variable	N	Mean	St. Dev.	Min	Max
C	399	219472	307985	4720	1300000
Y	399	497847	628878	10097	2800000
K	399	189041.6	255579	3593.04	977021
w1	399	85.563	50.005	6.704	238.418
w2	399	73.294	45.989	5.859	201.920
w3	399	102.53	12.24	55.84	205.61
w4	399	0.242	0.104	0.011	1.147
z1	399	353964	430217	17800	2200000
z2	399	4.76	3.33	0.46	13.72
z3	399	1.27	0.14	1.09	1.76
atcop=ATCOh/Y	399	1.69341	1.234088	.4936508	8.603349
FAB members	399	4.6	1.9	2	7
FAB size	399	1359694	704887	399000	2871000

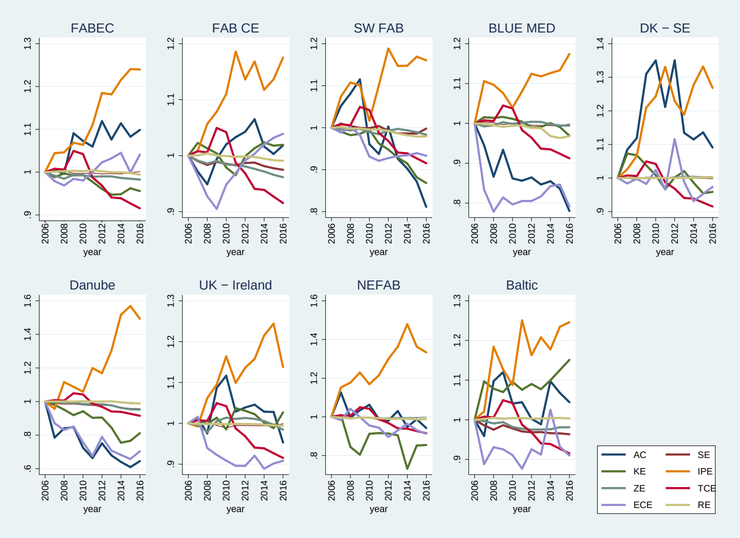
SFA results: frontier parameters

	Coef.		s.e.	t-ratio
Frontier parameters				
lnY	0.539	***	0.029	18.800
lnK	0.344	***	0.016	21.730
$ln(w2/w1)$	0.217	***	0.015	14.930
$ln(w3/w1)$	0.117	***	0.015	7.830
$ln(w4/w1)$	0.342	***	0.012	28.760
$0.5lnY^2$	0.095	*	0.057	1.660
$0.5lnK^2$	-0.094	**	0.038	-2.480
$0.5ln(w2/w1)^2$	0.025		0.048	0.530
$0.5ln(w3/w1)^2$	0.470	***	0.107	4.400
$0.5ln(w4/w1)^2$	0.278	***	0.044	6.280
$lnY * lnK$	0.065	*	0.040	1.650
$lnY * ln(w2/w1)$	0.049		0.040	1.240
$lnY * ln(w3/w1)$	0.043		0.068	0.640
$lnY * ln(w4/w1)$	-0.116	***	0.030	-3.820
$lnK * ln(w2/w1)$	-0.038		0.038	-1.010
$lnK * ln(w3/w1)$	-0.028		0.059	-0.470
$lnK * ln(w4/w1)$	0.127	***	0.030	4.220
$ln(w2/w1) * ln(w3/w1)$	-0.015		0.050	-0.300
$ln(w2/w1) * ln(w4/w1)$	0.033		0.039	0.830
$ln(w3/w1) * ln(w4/w1)$	-0.305	***	0.064	-4.790
$lnz1$	0.073	***	0.022	3.330
$z2$	-0.021	***	0.007	-2.830
$z3$	0.007		0.062	0.110
Intercept	11.299	***	0.021	532.140

SFA results: noise and inefficiency terms

	Coef.		s.e.	t-ratio
Noise term				
lnY	-5.881	***	0.682	-8.620
$lnz1$	7.622	***	0.711	10.720
$z2$	0.813	***	0.160	5.080
$z3$	15.713	***	2.114	7.430
Intercept	-10.831	***	0.722	-15.000
Inefficiency term				
t	-0.390	***	0.124	-3.140
$0.5t^2$	0.060	***	0.021	2.930
$ln(ATCOh/Y)$	2.161	***	0.264	8.180
FAB members	0.142	**	0.059	2.410
FAB size	-0.312	**	0.153	-2.040
Intercept	-3.182	***	0.325	-9.800

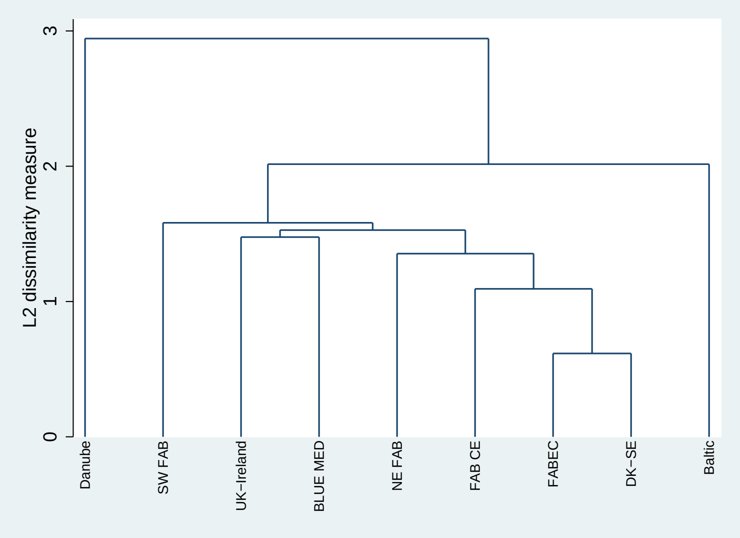
Time series decomposition



Estimated average annual percent change

FAB	$\dot{AC}$	SE	KE	IPE	ZE	TCE	ECE	RE	VRE
FABEC	1.02	-0.08	-0.45	2.20	-0.17	-0.85	0.43	-0.06	-0.14
FAB CE	0.22	-0.75	0.21	1.68	-0.39	-0.85	0.42	-0.09	-0.84
SW FAB	-1.87	-0.20	-1.39	1.62	-0.17	-0.85	-0.67	-0.21	-0.41
UK-Ireland	-0.35	-0.08	0.30	1.42	-0.15	-0.85	-0.91	-0.06	-0.14
BLUE MED	-2.34	-0.34	-0.31	1.69	-0.05	-0.89	-2.12	-0.32	-0.66
Danube	-3.76	-1.72	-1.96	4.43	-0.49	-0.85	-3.05	-0.12	-1.83
NEFAB	-0.35	-0.63	-1.00	3.12	-0.02	-0.85	-0.85	-0.12	-0.75
DK-SE	1.32	-0.08	-0.36	2.58	0.04	-0.85	-0.04	0.02	-0.06
Baltic	0.64	-1.59	1.47	2.49	-0.19	-0.85	-0.72	0.03	-1.55

Cluster analysis



Conclusions

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- **Danube:** able to show the best performance of all FABs in reducing average provision costs despite the fact of being also the FAB that shows the strongest input price effect.

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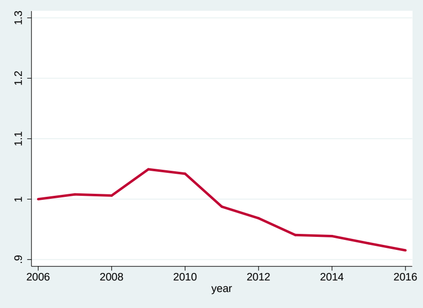
Conclusions

2 The **evolution of the technical change effect** may have two **interpretations**:

- The effect of the deadline of the SES legislation for the FABs to be fully operational (December 2012).
- The effect of the end of the full cost recovery regime that was applied to most ANSPs until December 2011.



Conclusions

3 if the FABs were to be effective tools in reducing inefficiencies, they should involve traffic redistribution actions between ANSPs. The **traffic redistribution effect (VRE=SE+RE) of Danube, Baltic, FAB CE and NEFAB**, may be reflecting the implementation of traffic redistribution actions such as cross border sectorisations and service provision.

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- This extension of the analysis could help shedding some light on the **concern that some financial cost–efficiency savings are accompanied by delay** (and other indirect) costs.