

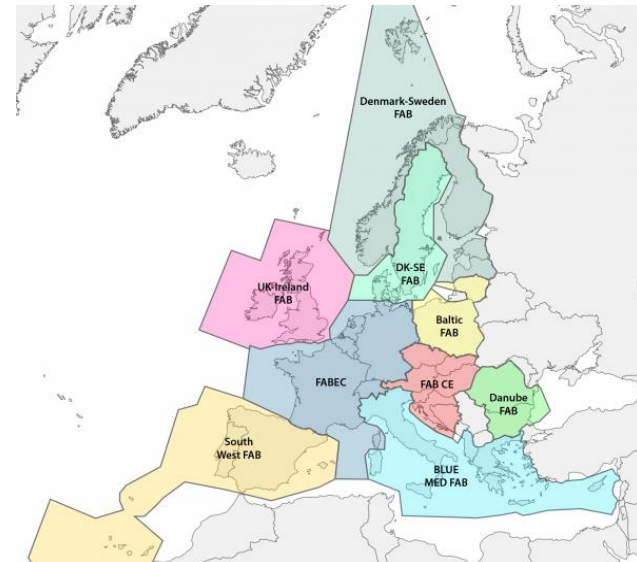


„Main Determinants of Volatility in Air Traffic and Its Impact on ANSP’s Performance“

Vilma Deltuvaite, Sarunas Murauskas / SE Oro navigacija / Baltic FAB

Research Workshop on Volatility in Air Traffic and its impact on ATM Performance
May 15-16, 2018
Warsaw, Poland

- Main trends in air traffic flows, air traffic volatility and complexity in the European Civil Aviation Conference (ECAC) countries and Baltic FAB



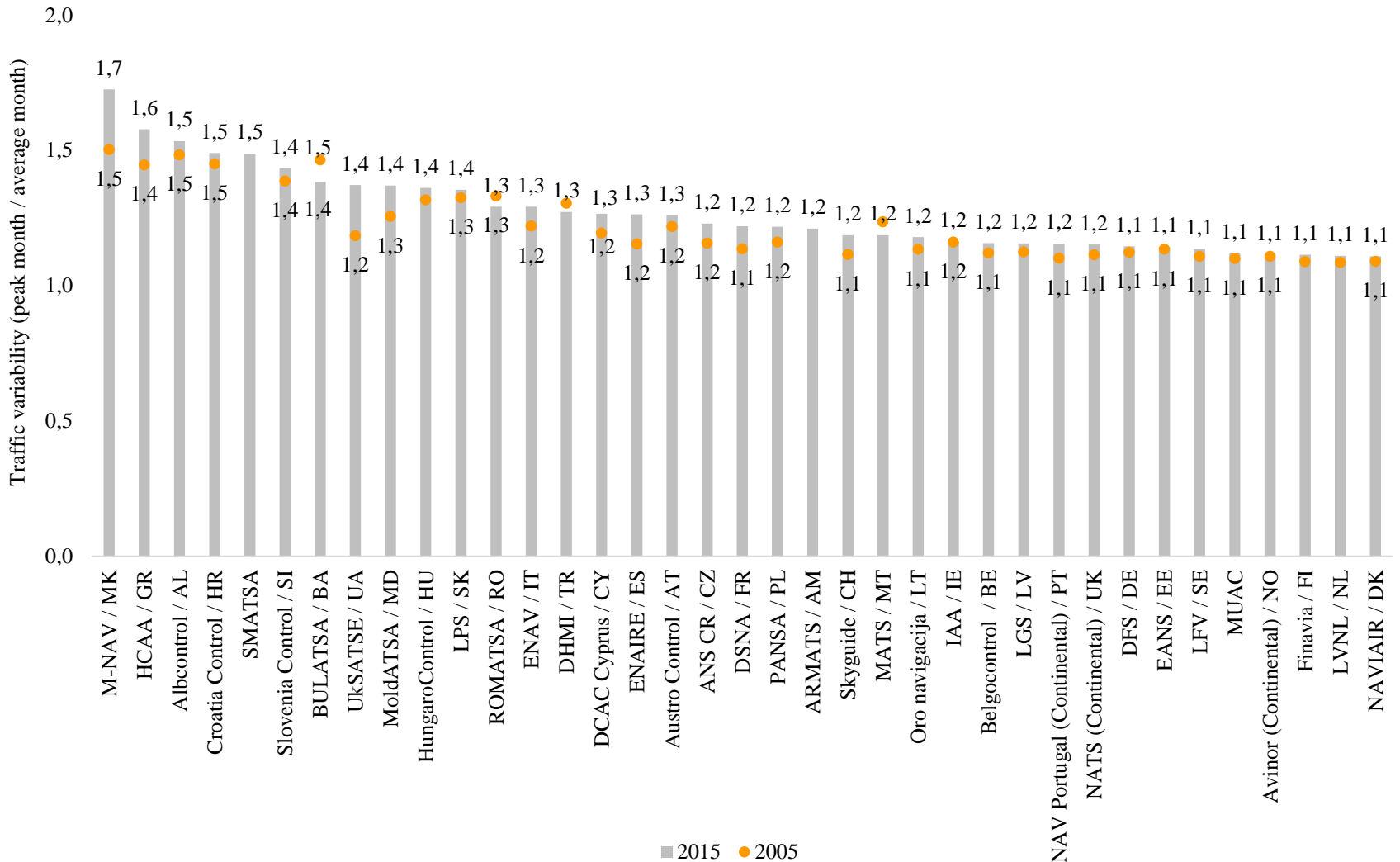
- Empirical results on determinants explaining:
 - air traffic volatility
 - ANSP's performance

Main trends in air traffic, air traffic volatility and complexity in ECAC countries

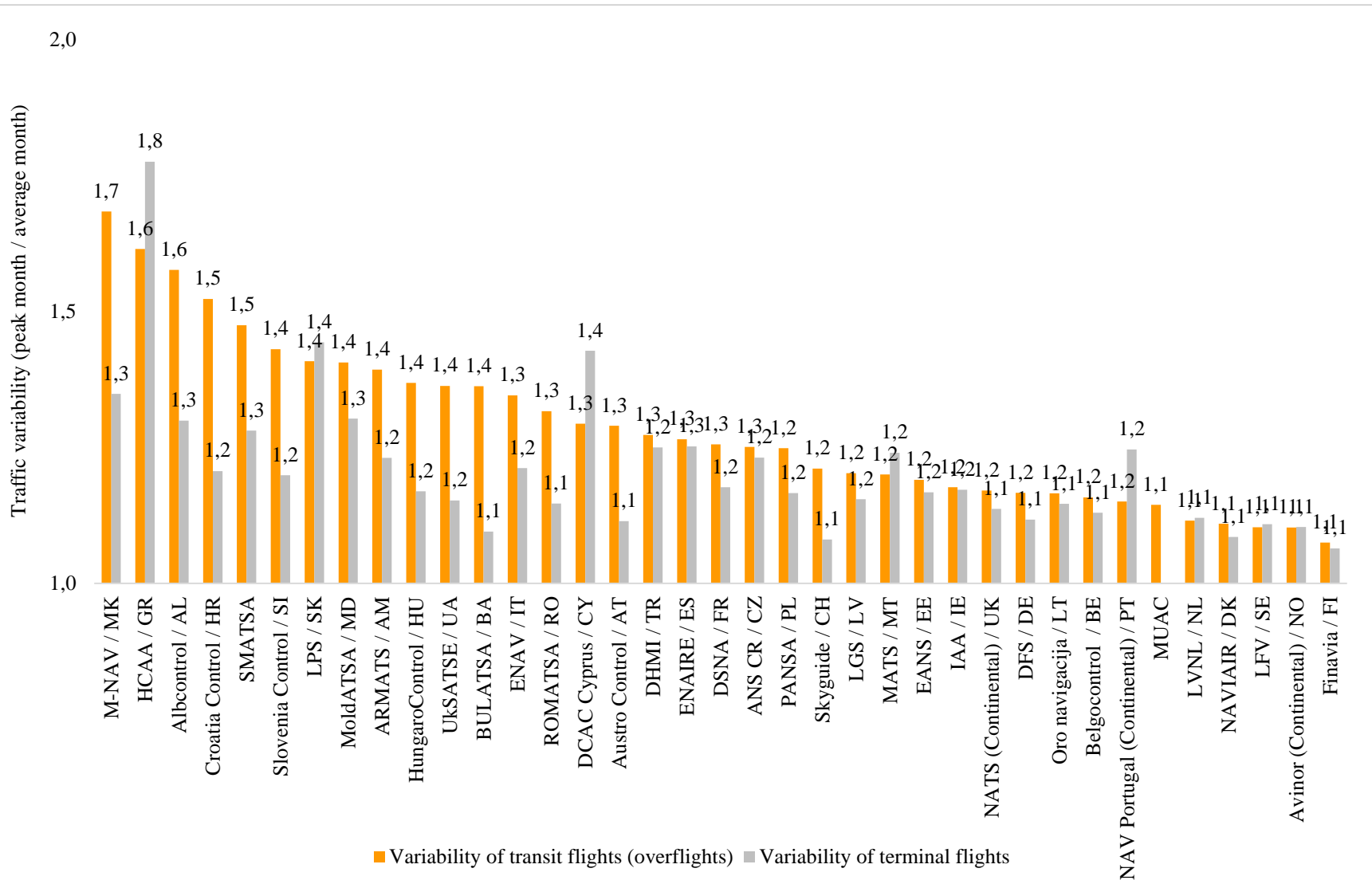


Total IFR flights controlled by the ANSP			
ANSPs/Country	2005	2015	Change 2015/2005 (in percent)
DHMI / TR	614 784	1 322 423	115
BULATSA / BA	398 539	771 068	93
Oro navigacija / LT	120 611	225 075	87
MoldATSA / MD	25 883	45 440	76
Albcontrol / AL	116 040	201 983	74
PANSA / PL	403 834	688 316	70
Croatia Control / HR	322 663	530 607	64
LGS / LV	154 260	242 554	57
EANS / EE	123 294	193 325	57
ROMATSA / RO	410 530	634 739	55
DCAC Cyprus / CY	208 490	319 091	53
LPS / SK	317 703	467 466	47
HungaroControl / HU	579 113	809 937	40
Slovenia Control / SI	193 002	267 411	39
M-NAV / MK	110 562	152 130	38
MATS / MT	75 417	102 774	36
NAV Portugal (Continental) / PT	374 882	504 381	35
HCAA / GR	547 911	712 434	30
ANS CR / CZ	576 956	730 979	27

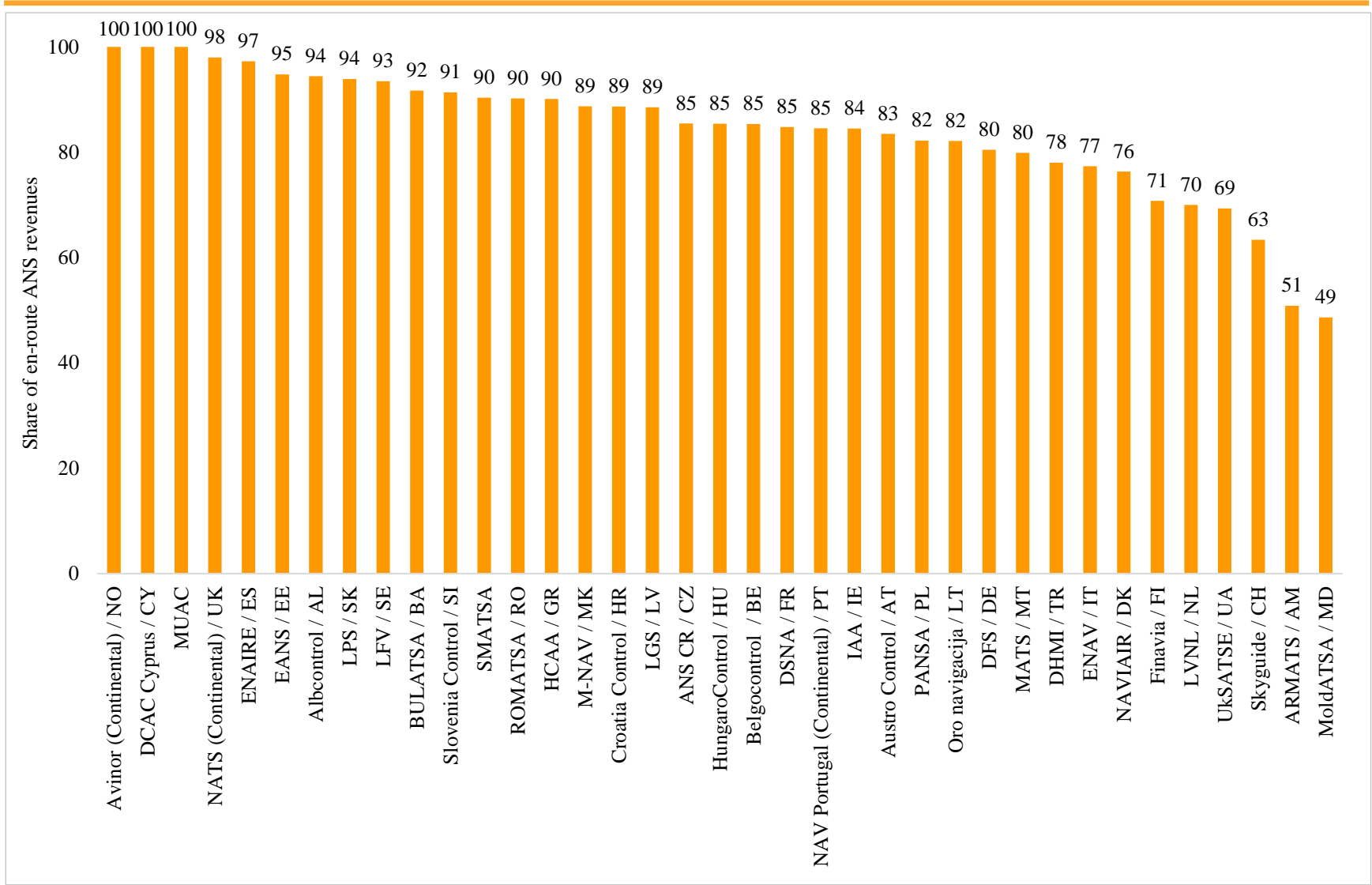
Total IFR flights controlled by the ANSP			
ANSPs/Country	2005	2015	Change 2015/2005 (in percent)
Avinor (Continental) / NO	486 066	604 635	24
MUAC	1 450 200	1 702 263	17
Austro Control / AT	831 441	915 007	10
DSNA / FR	2 655 494	2 887 215	9
LVNL / NL	540 145	585 439	8
LFV / SE	662 210	707 470	7
Belgocontrol / BE	553 945	591 480	7
DFS / DE	2 651 315	2 818 110	6
ENAV / IT	1 488 570	1 565 568	5
ENAIRES / ES	1 645 708	1 730 434	5
NAVIAIR / DK	614 476	641 881	4
IAA / IE	542 425	565 916	4
Skyguide / CH	1 137 287	1 184 665	4
Finavia / FI	230 880	229 226	-1
NATS (Continental) / UK	2 414 587	2 268 666	-6
UkSATSE / UA	312 053	213 133	-32
SMATSA		601 283	
ARMATS / AM		42 168	



Volatility of transit and terminal flights controlled by ANSPs in 2015



Share of en-route revenues in total revenues by ANSPs in 2015



Adjusted traffic density indicator = Hours of interactions / Flight hours

ANSPs/Country	2005	2015	Change 2015/2005
DHMI / TR	3,55	11,76	8,22
Skyguide / CH	10,19	11,38	1,19
MUAC	9,84	10,62	0,78
DSNA / FR	7,97	10,58	2,60
NATS (Continental) / UK	9,78	10,33	0,55
ANS CR / CZ	6,79	10,32	3,53
LVNL / NL	9,19	10,27	1,09
DFS / DE	9,66	9,99	0,33
BULATSA / BA	5,04	9,78	4,74
Slovenia Control / SI	4,45	9,68	5,23
SMATSA		9,24	
LPS / SK	5,20	9,13	3,93
HungaroControl / HU	6,65	8,95	2,30
Austro Control / AT	7,11	8,37	1,27
Croatia Control / HR	4,78	8,34	3,56
Belgocontrol / BE	8,45	8,04	-0,41
ROMATSA / RO	5,37	7,93	2,57
ENAIRES / ES	5,27	6,89	1,62
Albcontrol / AL	3,55	6,63	3,09

Adjusted traffic density indicator = Hours of interactions / Flight hours

ANSPs/Country	2005	2015	Change 2015/2005
ENAV / IT	5,40	5,75	0,35
DCAC Cyprus / CY	3,05	5,57	2,53
M-NAV / MK	4,32	5,55	1,23
HCAA / GR	3,35	4,42	1,08
NAV Portugal (Continental) / PT	3,28	4,39	1,11
PANSA / PL	3,35	4,25	0,90
IAA / IE	4,43	4,12	-0,31
EANS / EE	2,60	3,62	1,03
NAVIAIR / DK	3,87	3,58	-0,30
LGS / LV	3,04	3,27	0,24
LFV / SE	3,64	2,93	-0,71
Oro navigacija / LT	2,00	2,83	0,82
MATS / MT	0,97	2,63	1,66
UkSATSE / UA	2,30	2,14	-0,16
Avinor (Continental) / NO	1,62	2,14	0,52
Finavia / FI	2,88	1,69	-1,20
ARMATS / AM		1,16	
MoldATSA / MD	0,80	1,00	0,20

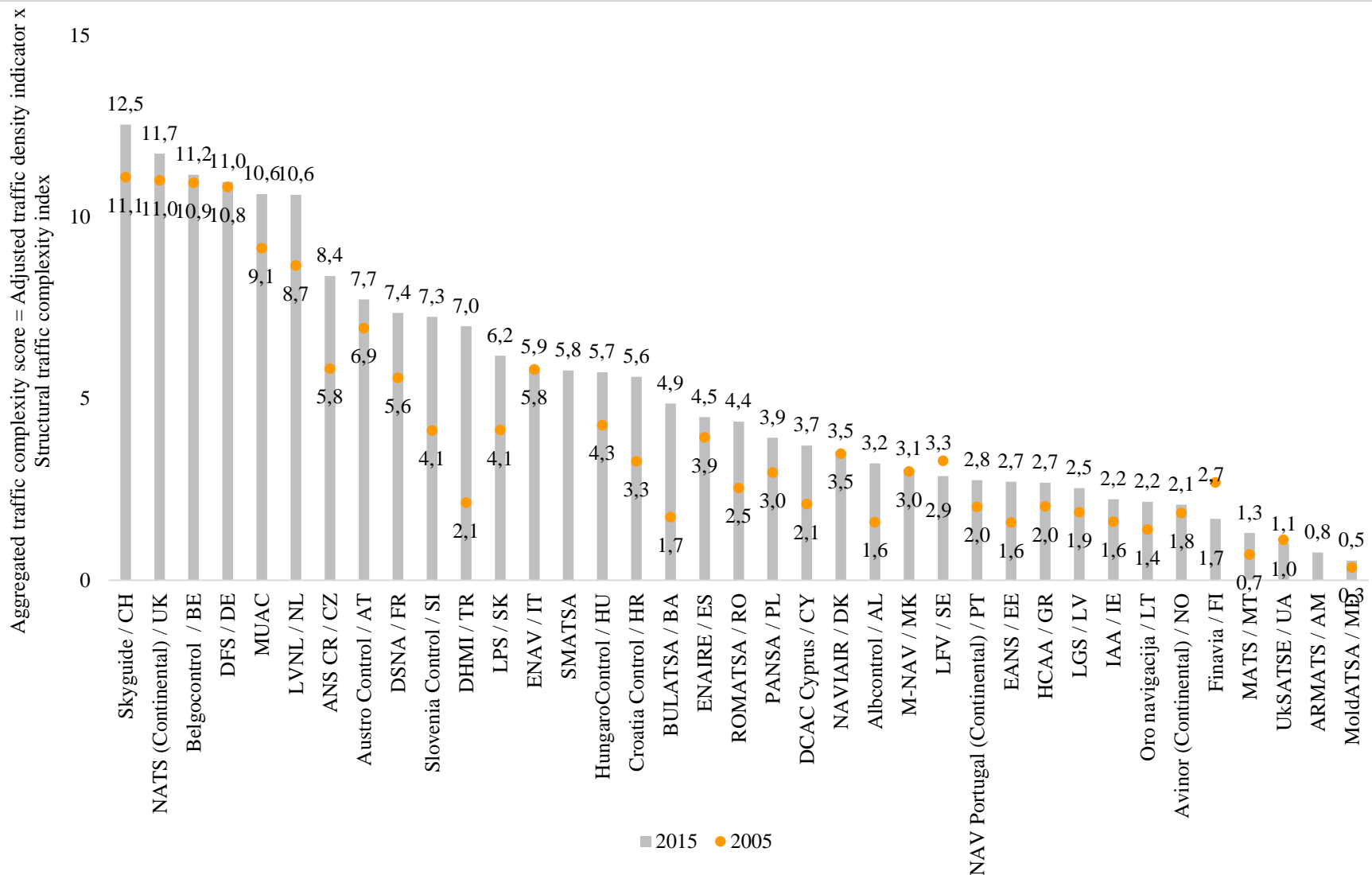
Structural traffic complexity index = Relative vertical different interacting flows indicator + Relative horizontal different interacting flows indicator + Relative speed different interacting flows indicator

ANSPs/Country	2005	2015	Change 2015/2005
Belgocontrol / BE	1,29	1,39	0,09
NATS (Continental) / UK	1,13	1,14	0,01
Skyguide / CH	1,09	1,10	0,01
DFS / DE	1,12	1,10	-0,02
LVNL / NL	0,94	1,03	0,09
ENAV / IT	1,07	1,02	-0,05
MUAC	0,93	1,00	0,07
Finavia / FI	0,93	1,00	0,07
NAVIAIR / DK	0,90	0,99	0,09
LFV / SE	0,90	0,98	0,07
Avinor (Continental) / NO	1,14	0,97	-0,17
Austro Control / AT	0,98	0,92	-0,05
PANSA / PL	0,89	0,92	0,04
ANS CR / CZ	0,86	0,81	-0,05
LGS / LV	0,61	0,77	0,16
Oro navigacija / LT	0,69	0,76	0,07
Slovenia Control / SI	0,92	0,75	-0,17
EANS / EE	0,61	0,75	0,14
DSNA / FR	0,70	0,70	0,00

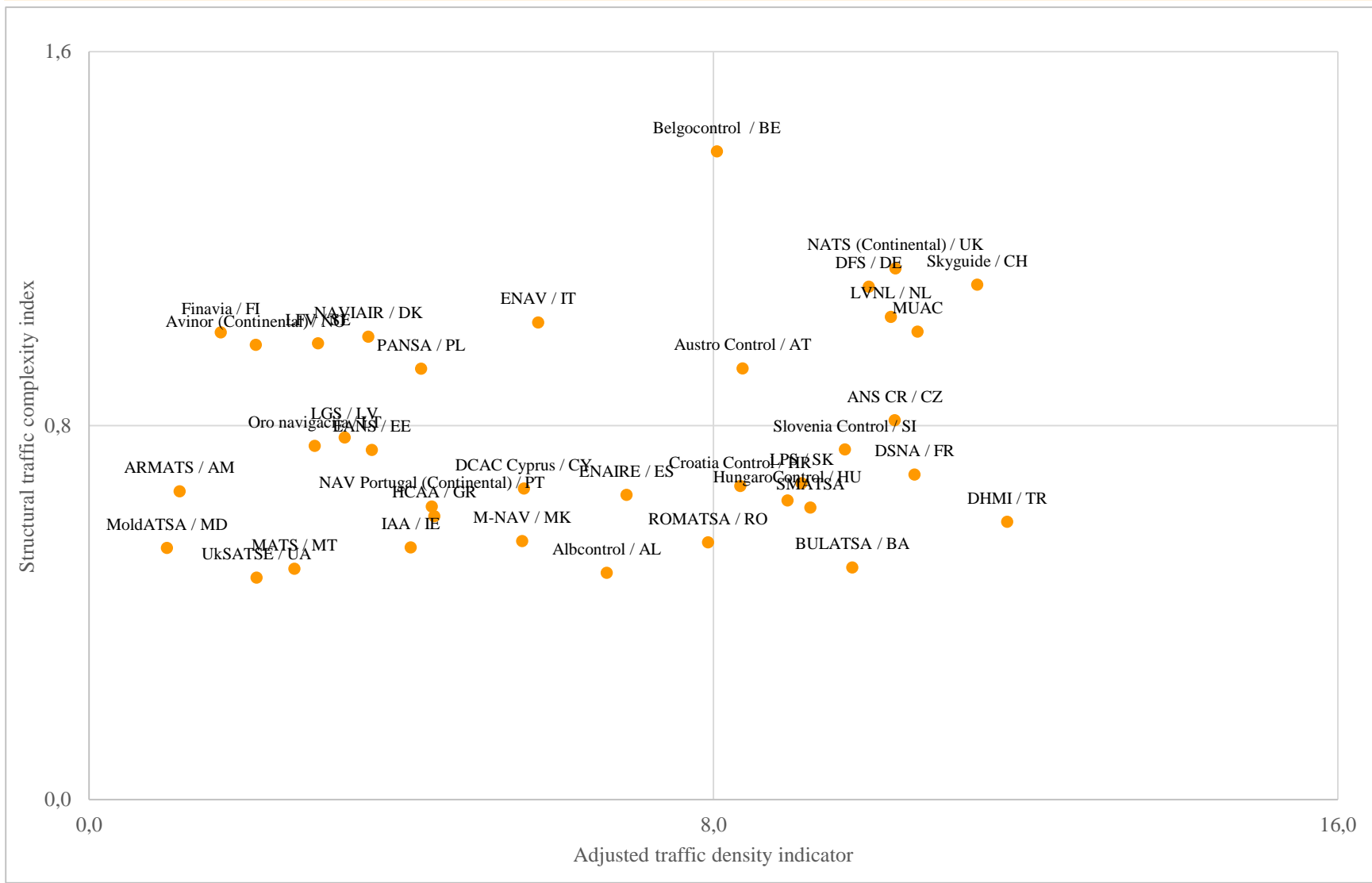
Structural traffic complexity index = Relative vertical different interacting flows indicator + Relative horizontal different interacting flows indicator + Relative speed different interacting flows indicator

ANSPs/Country	2005	2015	Change 2015/2005
LPS / SK	0,79	0,68	-0,12
Croatia Control / HR	0,68	0,67	-0,01
DCAC Cyprus / CY	0,69	0,67	-0,02
ARMATS / AM		0,66	
ENAIRES / ES	0,75	0,65	-0,09
HungaroControl / HU	0,64	0,64	0,00
NAV Portugal (Continental) / PT	0,61	0,63	0,01
SMATSA		0,62	
HCAA / GR	0,61	0,61	0,00
DHMI / TR	0,60	0,59	-0,01
M-NAV / MK	0,69	0,55	-0,14
ROMATSA / RO	0,47	0,55	0,08
IAA / IE	0,36	0,54	0,18
MoldATSA / MD	0,43	0,54	0,11
BULATSA / BA	0,34	0,50	0,15
MATS / MT	0,73	0,49	-0,24
Albcontrol / AL	0,45	0,49	0,04
UkSATSE / UA	0,48	0,48	-0,01

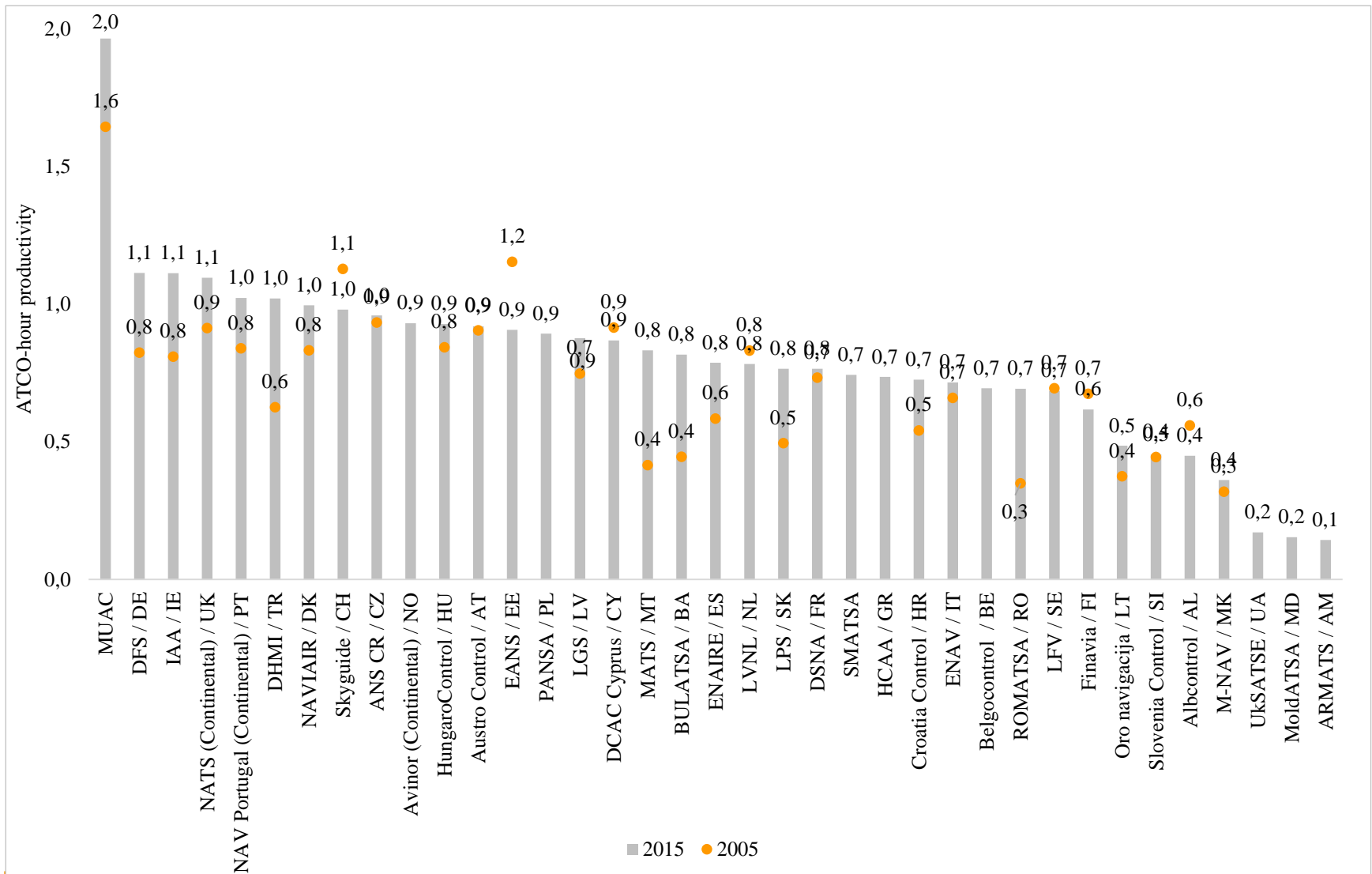
Trends in aggregated traffic complexity



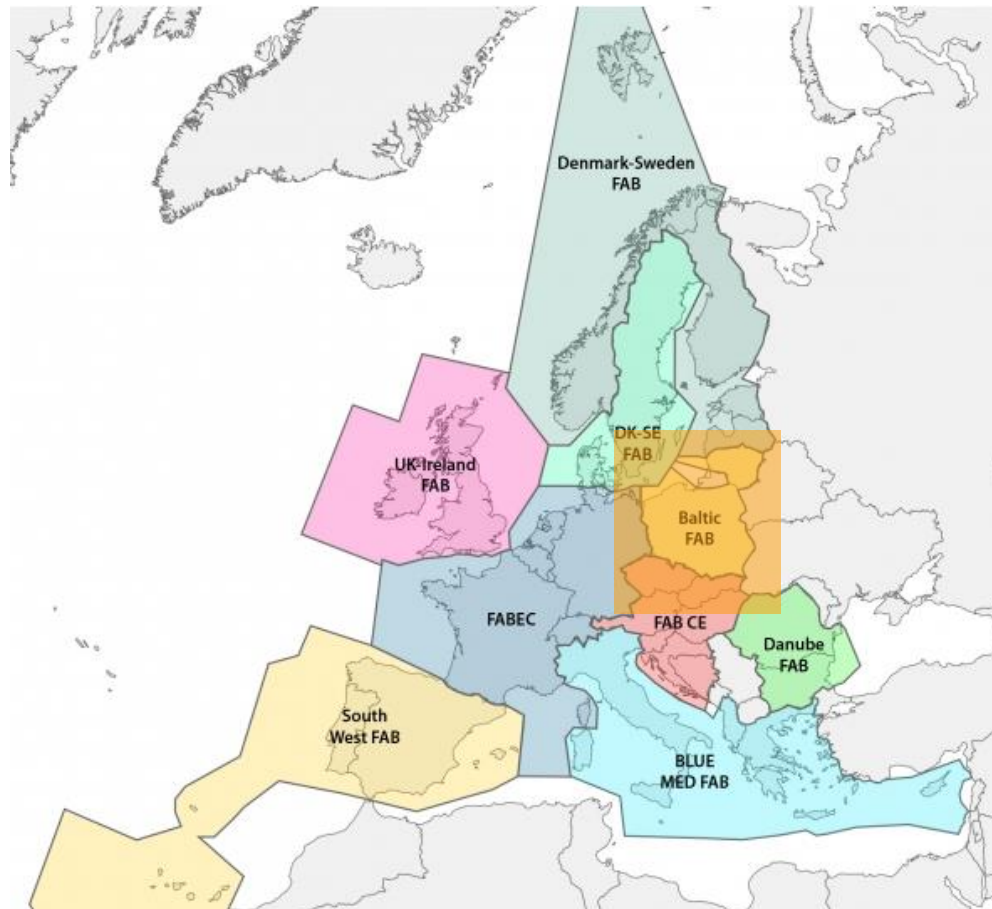
Traffic density and structural traffic complexity by ANSPs in 2015



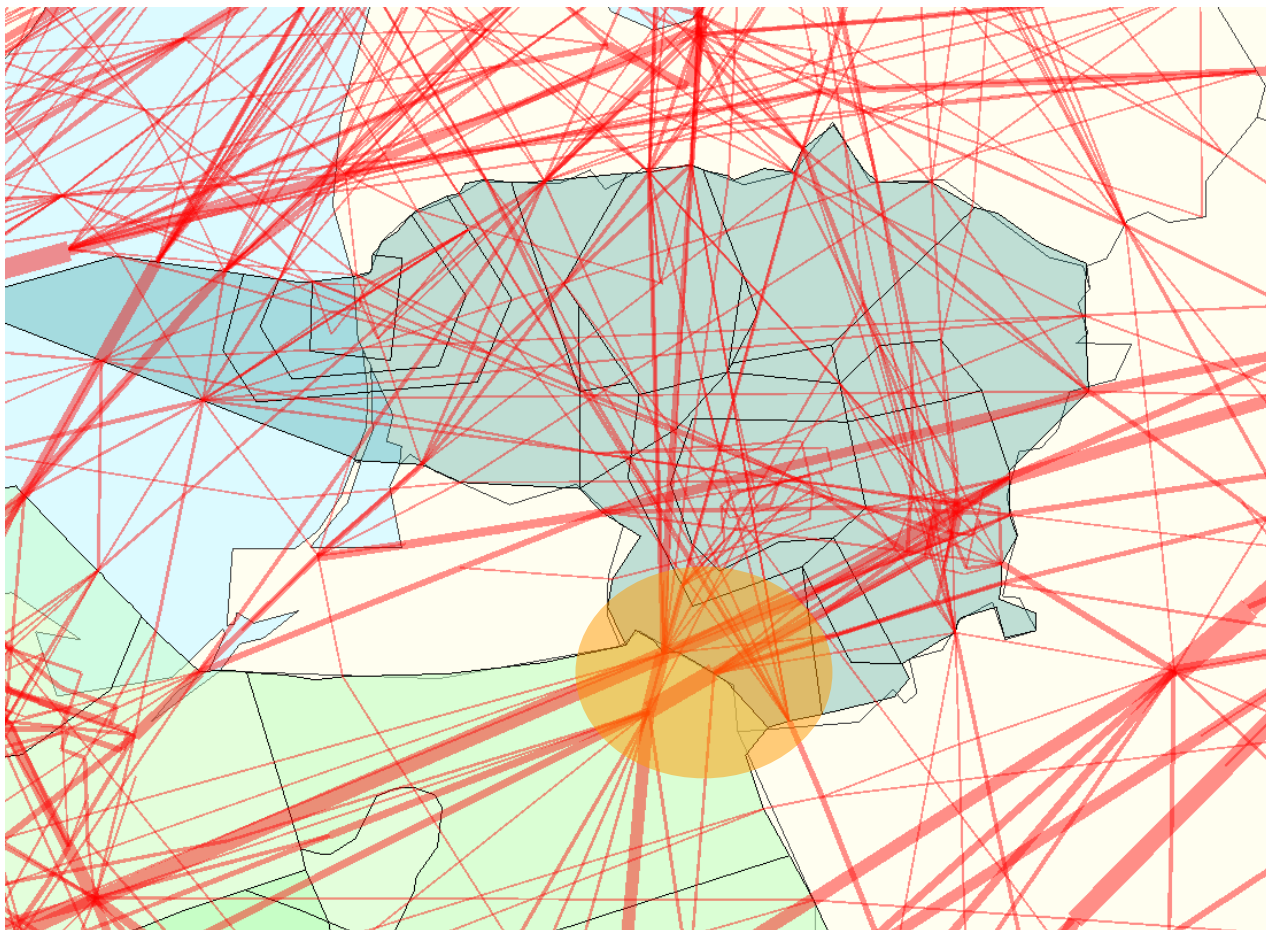
Trends in ATCO-hour productivity by ANSPs



Some special cases of changes in air traffic flows in Baltic FAB



The Suwalki Corridor statistics (2018 Q1 vs 2017 Q1)



	2018 Q1	2017 Q1	Dif	Dif, %
Overall cross-border flights	23 025	20 617	2408	+11,7

Data source: SE Oro navigacija

- Russian airlines were banned to enter the Ukrainian airspace from October in 2015
- Ukrainian airlines are also forbidden to operate direct flights from Ukrainian airports to Russian airports
- It led to increase the number of flights from/to Russia to/from Ukraine with the stop in Minsk, Riga, Vilnius and other cities
- This ban significantly changed Russian airlines routes flying from Russian northern part (e.g. Saint-Petersburg's International Pulkovo airport LED) to Greece, Middle Asia, Turkey or Africa. This is one of the main reasons why the number of Russian airlines en-route flights has grown in Lithuanian and Polish airspaces

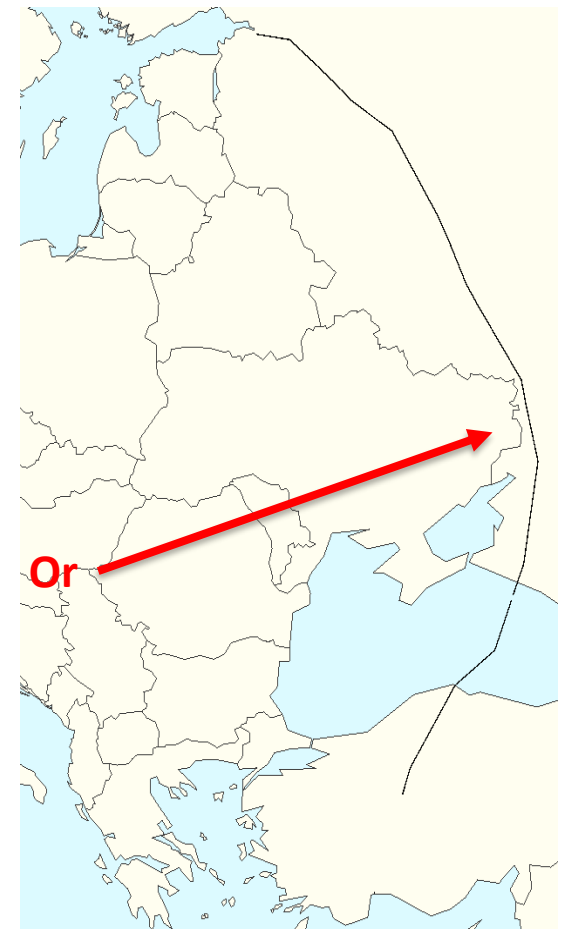
The effect of Russian airlines banned to enter the Ukrainian airspace (2)



15.07.04 LED-AYT SDM6833
Route length: 1454,40NM



17.07.04 LED-AYT SDM5863
Route length: 1634,46NM



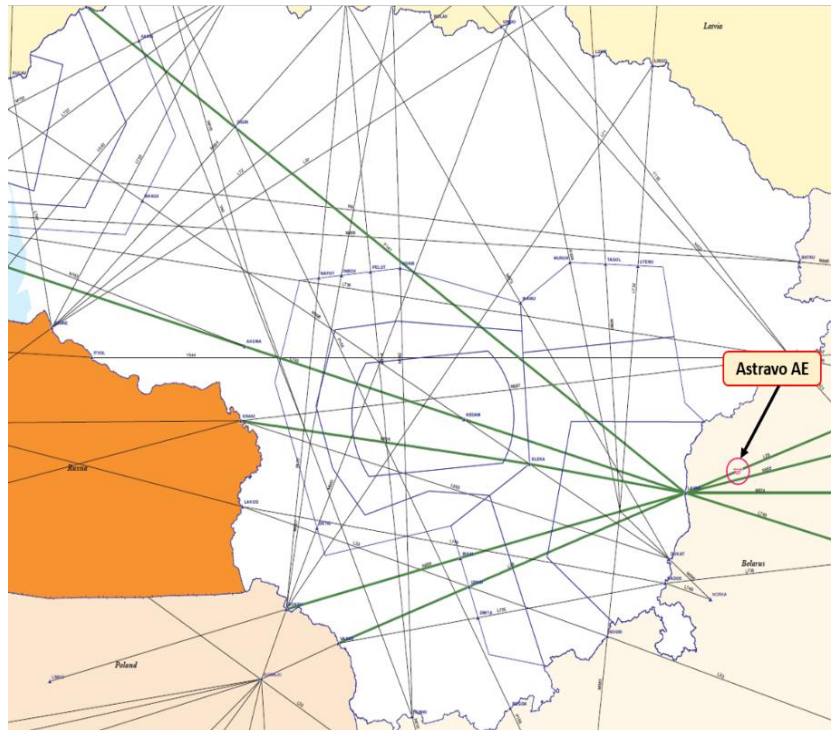
17.06.30 LED-AYT SDM5853
Route length: 1644,45NM

*Note: Eurocontrol do not cover the whole route information of these flights, that's why the route is not fully shown.

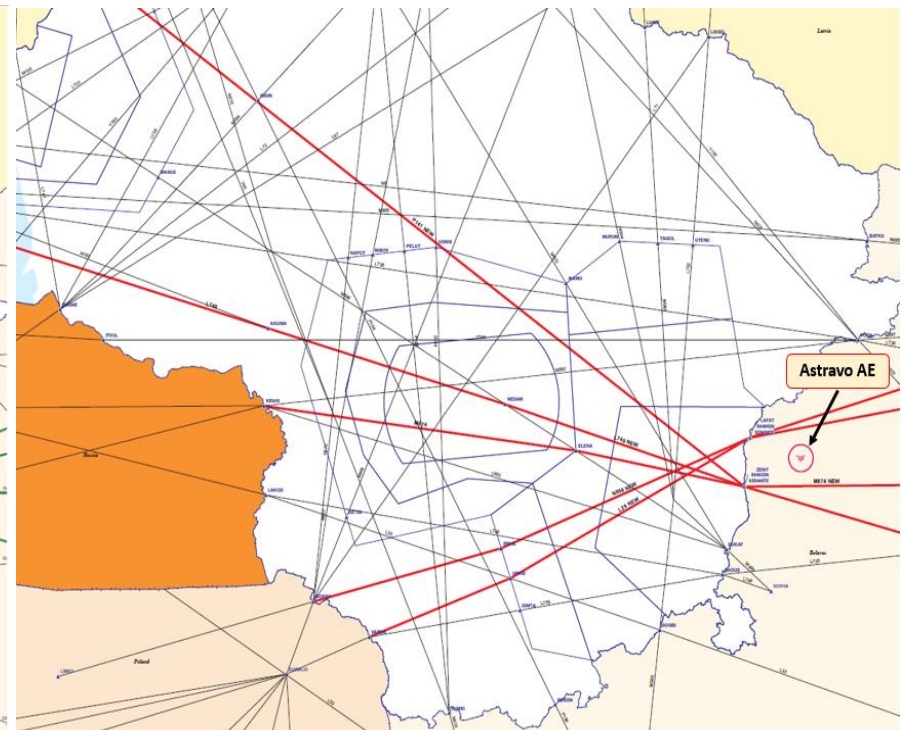
Data source: NEST tool

The impact of Belorussian nuclear power plant located in Astravyets (1)

Previously used routes



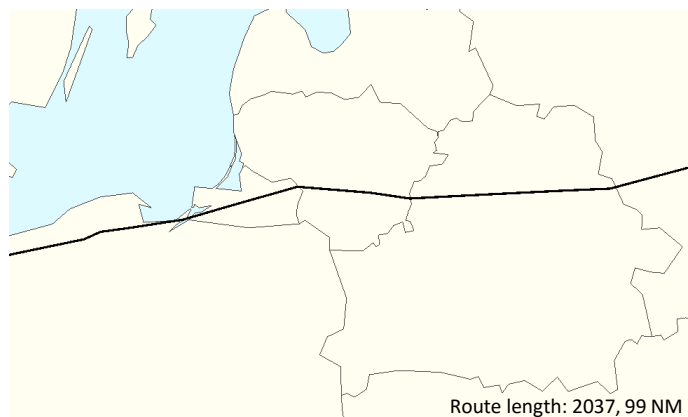
Redesigned routes



The previously used routes (flight KZR904 on 17.06.26 and 06.27)



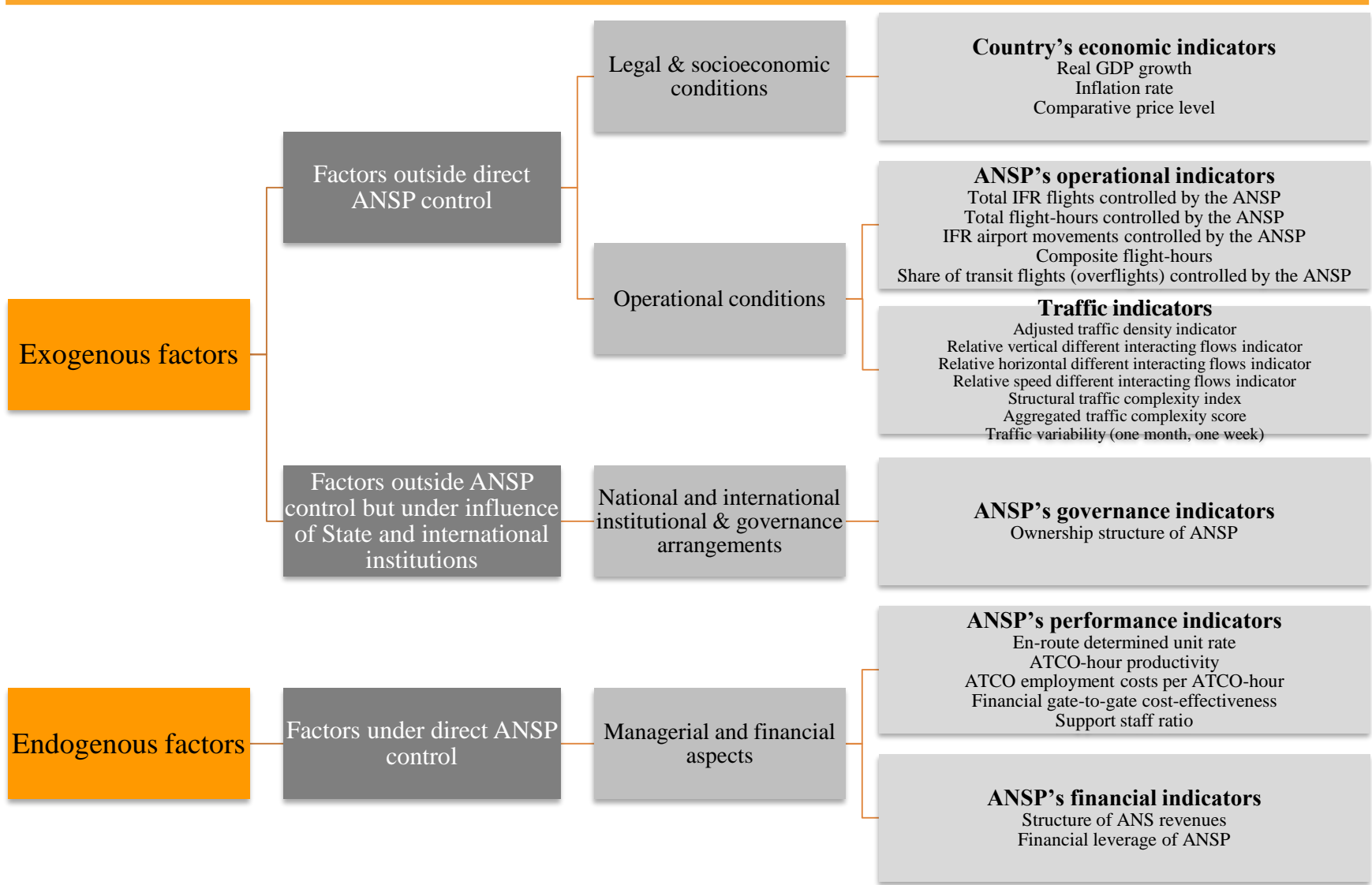
After redesigning the airspace



Data source: NEST tool

Empirical results on determinants explaining air traffic volatility and ANSP's performance





Investigation of an impact of exogenous and endogenous factors on ANSPs' performance was examined by applying a panel regression model (1).

¶

$$Y_{i,t} = \alpha + \beta_{i,t} X'_{i,t} + \delta_i + \gamma_t + \varepsilon_{i,t}, \quad \varepsilon_{i,t} \sim WN(0, \Sigma_\varepsilon) \quad \rightarrow \quad (1)$$

¶












where $Y_{i,t}$ is dependent variable characterizing ANSPs' performance (En-route determined unit rate (EDUR), ATCO-hour productivity (ATCOHP), ATCO employment costs per ATCO-hour (ATCOEC), Financial gate-to-gate cost-effectiveness (FGTGCE), Support staff ratio (SSR)), $X'_{i,t}$ is a k -vector of regressors, and $\varepsilon_{i,t}$ are the error terms for $i = 1, 2, \dots, M$ cross-sectional units (countries) observed for dated periods $t = 1, 2, \dots, T$. The α parameter represents the overall constant in the model, while the δ_i and γ_t represent cross-section and period effects. Transformation of all variables (except real GDP growth and inflation) has been performed by using chain index.

- **37 ANSPs providing en-route services in 39 ECAC Member States**



- **Time period from 2005 to 2015**
- **Total number of observations – 407**

Determinants of ANSP's performance: correlation analysis results (1)

A perfect negative linear relationship	A strong negative linear relationship	A moderate negative relationship	A weak negative linear relationship	A very weak negative linear relationship	No linear relationship	A very weak positive linear relationship	A weak positive linear relationship	A moderate positive relationship	A strong positive linear relationship	A perfect positive linear relationship
-1	(-1; -0,7]	(-0,7; -0,5]	(-0,5; -0,3]	(-0,3; 0)	0	(0; 0,3)	[0,3; 0,5)	[0,5; 0,7)	[0,7; 1)	1
										

Determinants of ANSP's performance: correlation analysis results (2)

Group of variables	Variable	ANSP's performance indicators				
		ATCO employment costs per ATCO-hour	ATCO-hour productivity	En-route determined unit rate	Financial gate-to-gate cost-effectiveness	Support staff ratio
Country's economic indicators	Real GDP growth		0,1191	-0,1359	-0,1013	-0,1059
	Inflation rate	-0,1426		0,2213	0,1822	
	Comparative price level	0,1399	0,1125		0,1474	0,1399
ANSP's performance indicators	En-route determined unit rate				0,3708	-0,1324
	ATCO-hour productivity	0,5373			-0,123	0,1342
	ATCO employment costs per ATCO-hour		0,5373			-0,1257
	Financial gate-to-gate cost-effectiveness		-0,123	0,3708		0,1733
	Support staff ratio	-0,1257	0,1342	-0,1324	0,1733	
ANSP's governance	Ownership structure of ANSP	0,0903	0,1175			0,086
ANSP's financial indicators	Structure of ANS revenues			0,2338		-0,3293
	Financial leverage of ANSP			-0,1781		0,1266

Determinants of ANSP's performance: correlation analysis results (3)

Group of variables	Variable	ANSP's performance indicators				
		ATCO employment costs per ATCO-hour	ATCO-hour productivity	En-route determined unit rate	Financial gate-to-gate cost-effectiveness	Support staff ratio
ANSP's operational indicators	Total IFR flights controlled by the ANSP	0,7042	0,4461	-0,2053		-0,1161
	Total flight-hours controlled by the ANSP	0,6576	0,5593	-0,2921	-0,1049	-0,1987
	IFR airport movements controlled by the ANSP	0,4539	0,3193			-0,3564
	Composite flight-hours	0,6651	0,5489	-0,268	-0,1136	-0,2449
	Share of transit flights (overflights) controlled by the ANSP	-0,0869	-0,1001	0,0406	0,1082	0,5432
Traffic indicators	Adjusted traffic density indicator	0,3803	0,2015			-0,0874
	Relative vertical different interacting flows indicator		0,1482	-0,1848		
	Relative horizontal different interacting flows indicator	0,3428	0,2521	-0,1231		
	Relative speed different interacting flows indicator	0,3035	0,3753	-0,1259		-0,1034
	Structural traffic complexity index	0,2576	0,3143	-0,1491		
	Aggregated traffic complexity score	0,3816	0,2436	-0,1423		-0,0956
	Traffic variability (one month)	0,093	-0,0922		-0,0739	
	Traffic variability (one week)	0,1051			-0,0934	

Determinants of air traffic volatility: correlation analysis results

Group of variables	Variable	Traffic volatility indicators	
		Traffic variability (one month)	Traffic variability (one week)
ANSP's operational indicators	Total IFR flights controlled by the ANSP	-0,0878	-0,0956
	Total flight-hours controlled by the ANSP	-0,1366	-0,1036
	IFR airport movements controlled by the ANSP	-0,1201	-0,1369
	Composite flight-hours	-0,1462	-0,1202
	Share of transit flights (overflights) controlled by the ANSP	0,1017	0,1032
Traffic indicators	Adjusted traffic density indicator		
	Relative vertical different interacting flows indicator	-0,4149	-0,4489
	Relative horizontal different interacting flows indicator		
	Relative speed different interacting flows indicator	-0,318	-0,2945
	Structural traffic complexity index	-0,2873	-0,3125
	Aggregated traffic complexity score		
	Traffic variability (one month)		0,9478
	Traffic variability (one week)	0,9478	

Determinants of ANSP's performance and air traffic volatility: panel regression results

Variable	Dependent variable – ATCO employment costs per ATCO-hour	Dependent variable – ATCO-hour productivity	Dependent variable – En-route determined unit rate	Dependent variable – Financial gate-to-gate cost-effectiveness	Dependent variable – Support staff ratio
Aggregated traffic complexity score		-0.076120			
Adjusted traffic density indicator		0.083513			
Composite flight-hours	8.831325				-1.694252
Comparative price level	0.636023			1.045832	
IFR airport movements controlled by the ANSP	-1.675185	-0.294491			
Total IFR flights controlled by the ANSP	1.371338	-0.236357	-0.246354		
Total flight-hours controlled by the ANSP	-6.959890				1.279383
Structural traffic complexity index	-0.239017	0.119609			
Traffic variability (one month)		-1.066755	-0.549220		
Traffic variability (one week)		1.050463			

