GARS Workshop
Schiphol airport & Hogeschool van Amsterdam 2006

The Performance of Italian Airports

Bergamini Elisabetta', Gitto Simone°, Paolo Mancuso°

' ENAC (Ente Nazionale Aviazione Civile)
°Dipartimento di Igegneria dell'Impresa
Università degli Studi di Roma "Tor Vergata". Rome, Italy.

Summary

- Motivations
- Data
- The main problem
- The Methodological Approach: the three steps
  - Reducing dissimilarity *(factorial and cluster analysis)*
  - Measuring Productivity *(Torqvinst index)*
- Empirical evidences
- Concluding remarks

- Motivations and Aims

A conversation with Professor Jürgen Müller in the traffic of Rome

to join a research network

to study the operating efficiency of the Italian airports

Data

total airports: 37
airports considerd: 14

data coverage:
national traffic: 70%
international traffic: 77%
wlu: 75%

time period: 2000-2004.

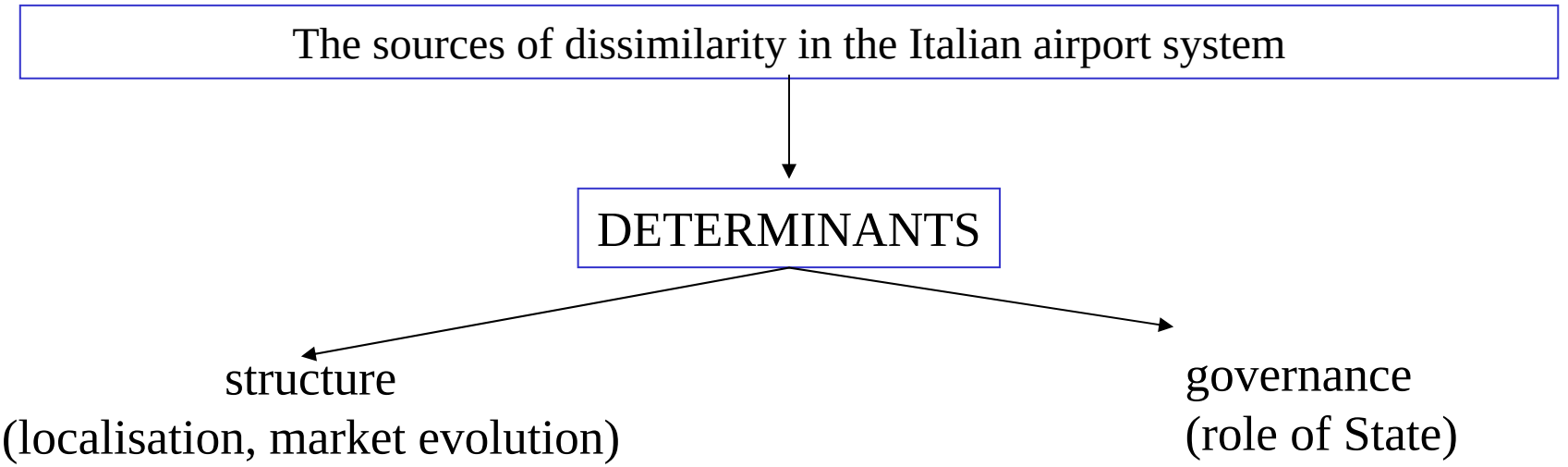
Sources:
ENAC (Ente Nazionale Aviazione Civile)

Assoaeroporti
www.assoaeroporti.it

➢ The main problem

The **problem**: airport dissimilarties

"airport benchmarking is challenging because of the so called 'uniqueness' of the airports, as operation of every airport slightly differs from another"(Kamp Müller Niemeier (2005) .



➢ The main problem

Structural sources (1/2)

Hub vs Spoke

	national (%)	international (%)	wlu(%)
Aiport System 1			
Rome Fiumicino Hub (FCO)	26.69	27.39	27.20
Rome Ciampino (CIA)	0.061	2.57	1.51
Tot. (1).	26.75	29.96	28.71
Airport System 2			
Milan Malpensa Hub (MPX)	9.09	29.04	21.20
Milan Linate (LIN)	11.81	4.48	7.72
Bergamo (BGY)	0.74	3.10	2.95
Tot. (2)	21.62	36.62	31.87
Tot. (1) + Tot. (2)	48.30	66.58	60.58

- The main problem

Structural sources (2/2)

Demand characteristics (2000-2004)

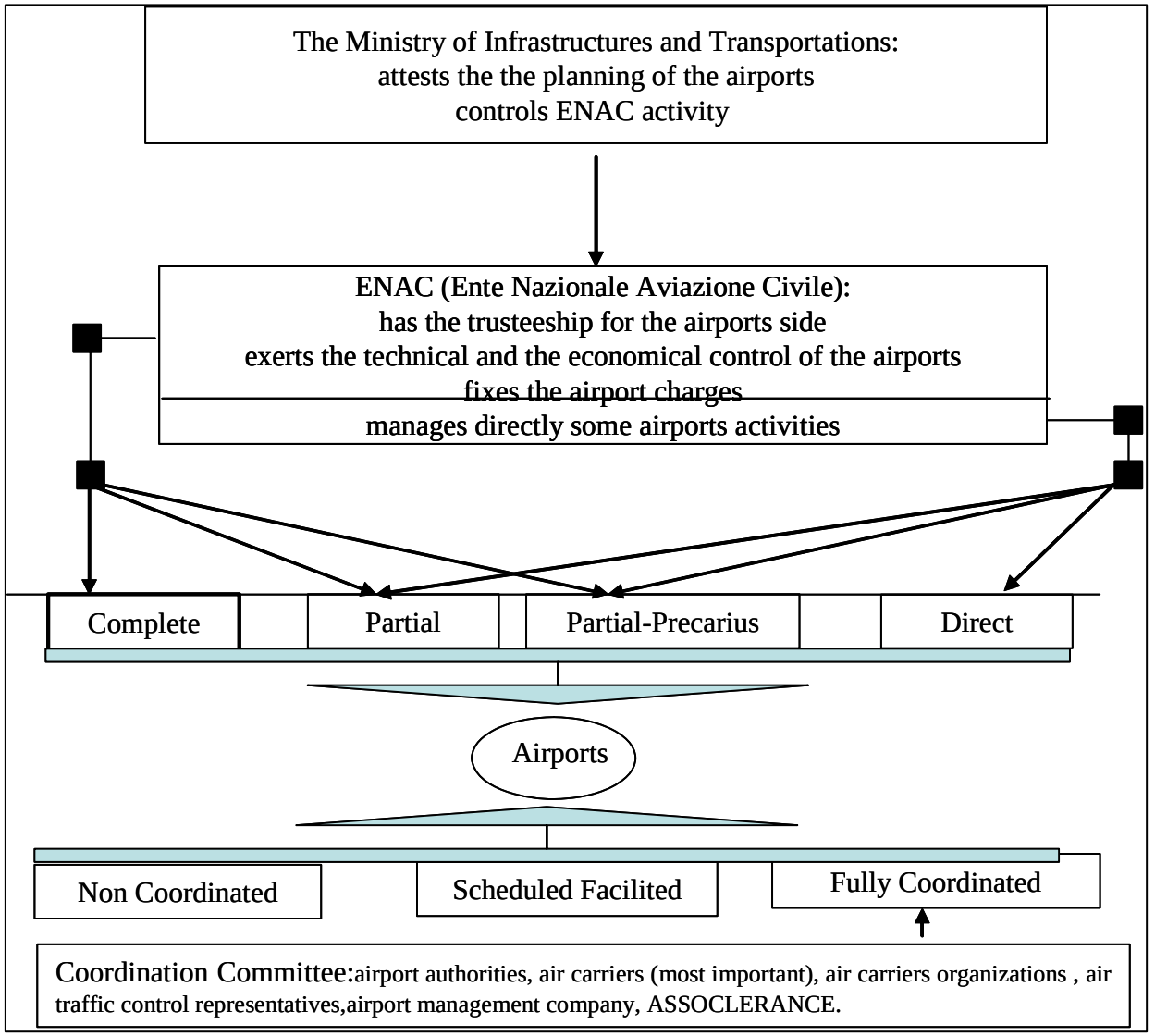
	Traffic					
	national		international		transit	
	trend	seasonality	trend	seasonality	trend	seasonality
Alghero (AHO)	growth	high	growth	high	stationary	high
Ancona (AOI)	decline	absent	growth	absent	growth	absent
Bergamo	stationary	absent	growth	absent	growth	absent
Rome Ciampino (CIA)	decline	absent	growth	absent	stationary	absent
Catania (CTA)	growth	high	stationary	high	stationary	high
Rome Fiumicino (FCO)	stationary	absent	growth	moderate	stationary	absent
Genova (GEO)	stationary	absent	decline	moderate	growth	absent
Milano Linate (LIN)	growth	absent	decline	low	growth	absent
Lamezia Terme (SUF)	stationary	moderate	growth	high	growth	absent
Milano Malpensa (MPX)	decline	high	growth	high	decline	absent
Palermo (PMO)	growth	high	growth	moderate	decline	absent
Pisa (PSA)	stationary	absent	growth	high	stationary	absent
Pescara (PSR)	stationary	absent	growth	moderate		
Verona (VRN)	growth	high	growth	high	growth	absent

Montly data ARIMA models

➢ The main problem

Governance sources (1/4)

Role of Italian State



➢ The main problem

Governance sources (2/4)

concession agreement

complete

revenues from all airport services (air side and landside) <u>manage and develop infrastructures</u>

partial

revenues from airport rights (passengers and freights) <u>maintenance of the terminal building and its pertinence</u>

partial-precarius

revenues from commercial activities

Before 1993, law n. 537/93, the “complete concession” was guaranteed to:Genova, Milan, Turin and Rome.

capital composition

law n. 351/1995 has repealed the duty by the State to hold the control but…..

➢ The main problem

Governance sources (3/4)

concession agreement | *capital composition*

Airport (IATA code)	Concession			Capital Composition	
	Complete	Partial	Partial Precarius	mixed priv.-pub.(govern.) ownership with a priv. maj.	mixed priv.-pub.(govern.) ownership with a pub. Maj.
Alghero (AHO)					
Ancona (AOI)					
Bergamo (BGY)					
Catania (CTA)					
Genova (GOA)					
Lamezia (SUF)					
Milano Linate (LIN)					
Milan Malpensa (MXP)					
Palermo (PMO)					
Pescara (PSR)					
Pisa (PSA)					
Roma Ciampino (CIA)					
Roma Fiumicino (FCO)					
Verona (VRN)					

➢ The main problem

Governance sources (4/4)

slot allocation

Airport (IATA code)	Non Coordinated Airport *(level 1)*	Scheduled Facilitated Airport *(level 2)*	Fully Coordinated Airport *(level 3)*
Alghero (AHO)			
Ancona (AOI)			
Bergamo (BGY)			
Catania (CTA)			
Genova (GOA)			
Lamezia (SUF)			
Milano Linate (LIN)			
Milan Malpensa (MXP)			
Palermo (PMO)			
Pescara (PSR)			
Pisa (PSA)			
Roma Ciampino (CIA)			
Roma Fiumicino (FCO)			
Verona (VRN)			

➢ The Methodological Approach

Therefore…try to group the Italian airports (14)

Step one: factorial analysis

A statistical multivariate methodology which allows to reduce the number of variables without loosing most of the overall variance (i.e. information).

Step two: cluster analysis

A statistical multivariate methodology which allows to group units with the goal of minimizing variance into the groups and maximizing the variance between groups.

Software Spad 3.5

➢ The Methodological Approach

The set of variables (Voegel, 2005)

Indicator	Definition	Type	Mean	Std. deviation	Coeff. Variation
Operations ratios					
return on asset (roa)	net income divided by total asset	continuous	0.017	0.047	2.700
return on capital employed (roce)	operating profit divided by total asset	continuous	0.057	0.068	1.200
operating margin	*ebit* divided by total revenue	continuous	0.081	0.116	1.429
ebitda margin	*ebitda* divided by total revenue	continuous	0.196	0.140	0.713
return on sales (ros)	net income divided by total revenue	continuous	0.023	0.079	3.384
return on equity (roe)	net income divided by equity	continuous	0.022	0.153	6.855
non aeronautical share of total revenue	non aeronautical revenue divided by total revenue	continuous	0.286	0.105	0.366
revenue/Expenditure ratio	total revenue divided by total cost	continuous	1.105	0.132	0.120
labour cost/total cost	labour cost divided by total cost	continuous	0.402	0.113	0.280
fixed asset turnover	total revenue divided by fixed asset	continuous	1.308	0.678	0.519
total asset turnover	total revenue divided by total asset	continuous	0.680	0.190	0.280
total revenue/equity	total revenue divided by equity	continuous	1.836	1.112	0.605
operating cost/wlu	inflation-adjusted operation cost divided by wlu	continuous	0.095	0.039	0.412
depreciation cost/wlu	inflation-adjusted depreciation cost divided by wlu	continuous	0.014	0.007	0.544
total cost/wlu	inflation-adjusted total cost divided by wlu	continuous	0.109	0.041	0.374
asset utilisation	total wlu divided by total asset	continuous	0.054	0.024	0.449
total revenue/wlu	inflation-adjusted total revenue divided by wlu	continuous	0.119	0.041	0.345
aeronautical revenue/wlu	inflation-adjusted aeronautical revenue divided by wlu	continuous	0.082	0.021	0.260
commercial revenue/pax	inflation-adjusted commercial revenue divided by passenger	continuous	0.030	0.017	0.564
wlu/employees	wlu divided by employees	continuous	9106.71	2913.62	0.320
wlu/airport size	wlu divided airport size	continuous	9988.46	7525.54	0.753
wlu/movement	wlu divided by aircraft movement	continuous	71.357	21.257	0.298
Capital ratios		continuous			
debt ratio	total debt divided by total asset	continuous	0.548	0.148	0.269
debt/equity	total debt divided by equity	continuous	1.835	1.663	0.906
financial leverage	total asset divided by equity	continuous	3.027	1.813	0.599

Indicator	Definition	Type	Mean	Std. deviation	Variation coefficient
wlu	work load unit	continuous	6560870	10493615	1.59
national/international passenger	national passenger divided by international passenger	continuous	2.04	2.06	1.01
airport size	airport area	continuous	493.50	555.13	1.12
national passenger	national terminal passenger	continuous	2712236	3910286	1.44
international passenger	International terminal passenger	continuous	3171162	5637945	1.78
hub	the value is 1 if the airport is the hub of a network hub and spoke, 0 otherwise	dicotomic			
spoke	the value is 1 if the airport is spoke of a network hub and spoke, 0 otherwise	dicotomic			
complete concession	the value is 1 if the airport has the complete concession, 0 otherwise	dicotomic			
partial concession	the value is 1 if the airport has the partial concession, 0 otherwise	dicotomic			
partial-precarious concession	the value is 1 if the airport has the partial-precarious concession, 0 otherwise	dicotomic			
national airports	the value is 1 if the airport has major national passenger traffic, 0 otherwise	dicotomic			
international airports	the value is 1 if the airport has major international passenger traffic, 0 otherwise	dicotomic			

35 variables

➢ The Methodological Approach

Step three: measuring operating efficiency (Oum et al 2006).

Output variables: the number of passengers, the volume of air cargo, the number of aircraft movements and revenues from non aeronautical services.
Input variables: labour, capital and soft costs.

Index formulation: Tornqvist (Cave, Christensen and Diewert; 1982)

Free software TIFPIP (Coelli; 1997)

For each cluster:

- Total Factor Productivity (TFP)
- Variable Factor Productivity (VFP)
- Residual Factor Productivity (RTFP)
- Residual Variable Factor Productivity (RVFP)

➢ Empirical evidences

Step one: factorial analysis

The first two factors explain about 83% of the overall variance.

Variables	factors		
	F1	F2	F3
actives			
wlu	0.4	0.85	-0.11
asset utilisation *(au)*	-089	0	0.43
non aeronautical share of total revenue *(nastr)*	0.87	-0.16	0.47
roce	-0.23	0.91	0.09
illustratives			
national\international *(nat\int)*	-0.61	-0.16	0.52
total cost\wlu *(tcw)*	0.74	-0.36	0.14
fixed assed turnover *(fat)*	-0.67	-0.03	0.66
aeronautical revenue\wlu *(arpw)*	0.51	0.11	-0.3
commercial revenues\pax *(crp)*	0.78	-0.04	0.28
airport size *(as)*	0.44	0.83	-0.03

➢ Empirical evidences

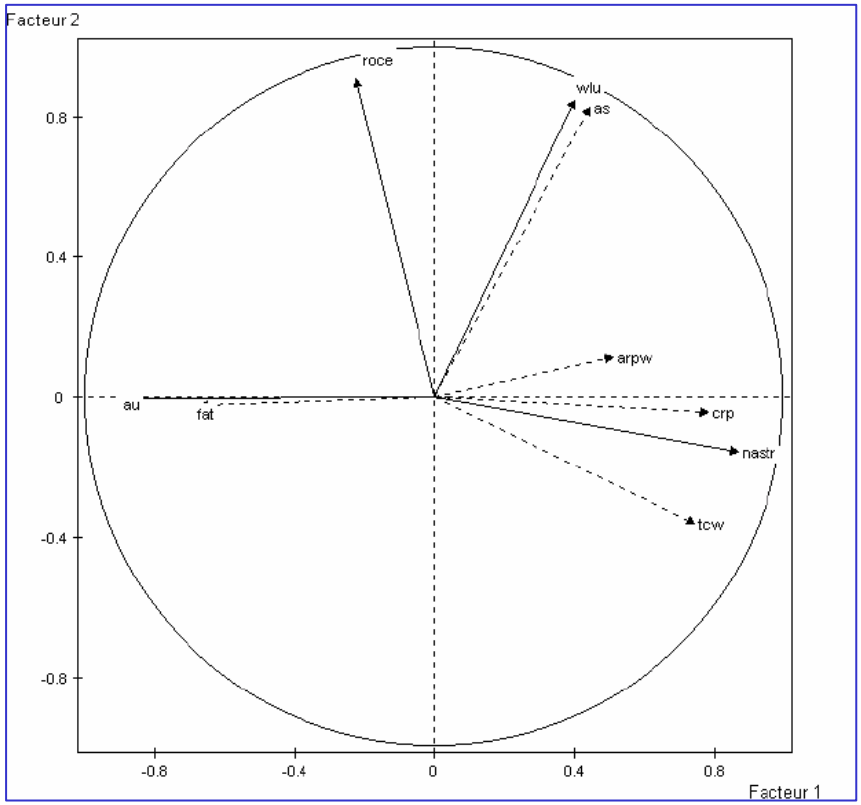
Step one: factorial analysis

labelling the factors

Factor, *F1*, when is negative: it measures of the degree of the airport capacity utilisation.

Factor, *F1*, when is positive: it measures the airport revenues composition

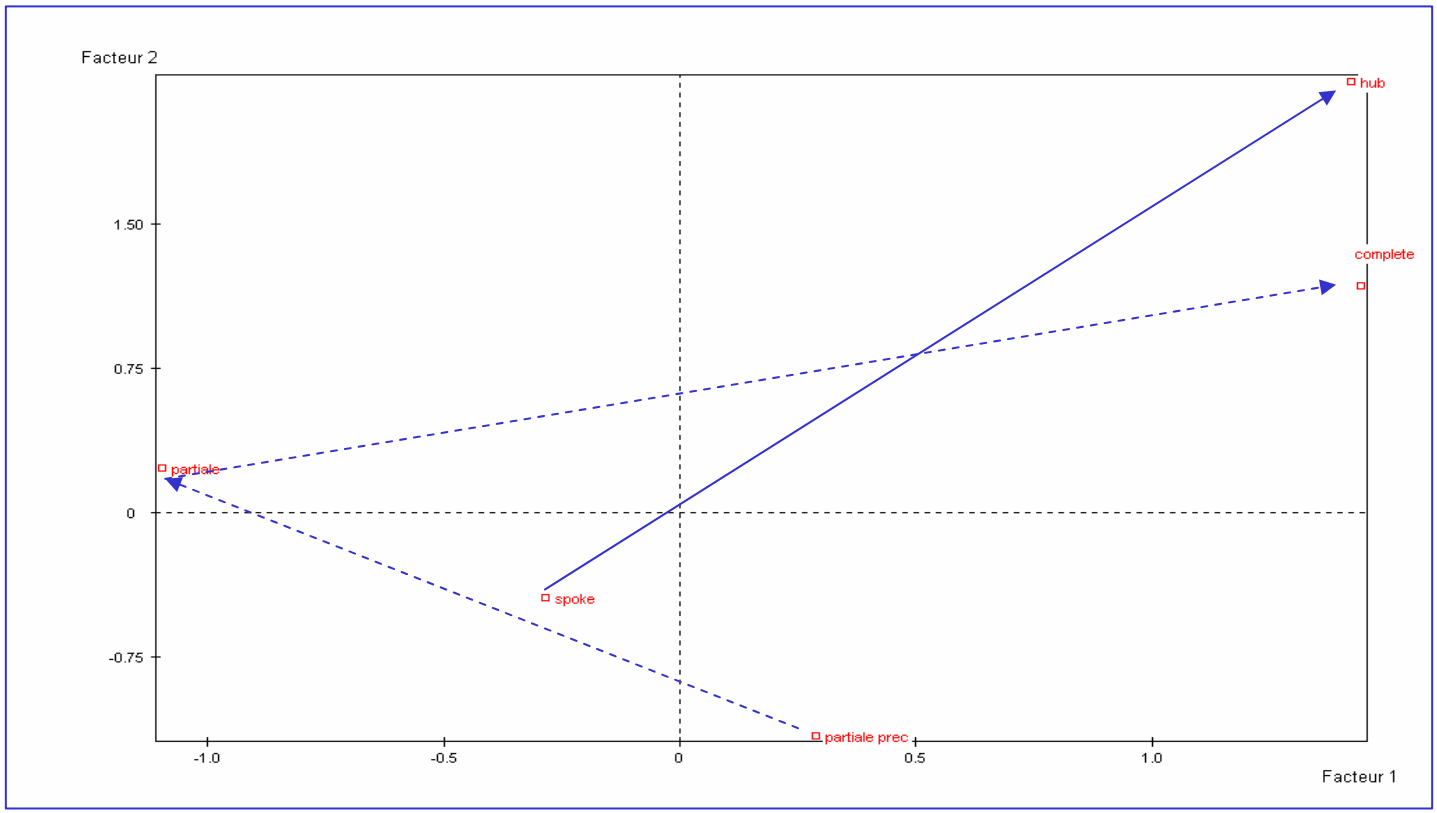
Factor, *F2*: it measures the airport airport economic efficiency.



➢ Empirical evidences

Step one: factorial analysis

The effect of the concession agreement and of the role played by the airport in the structure

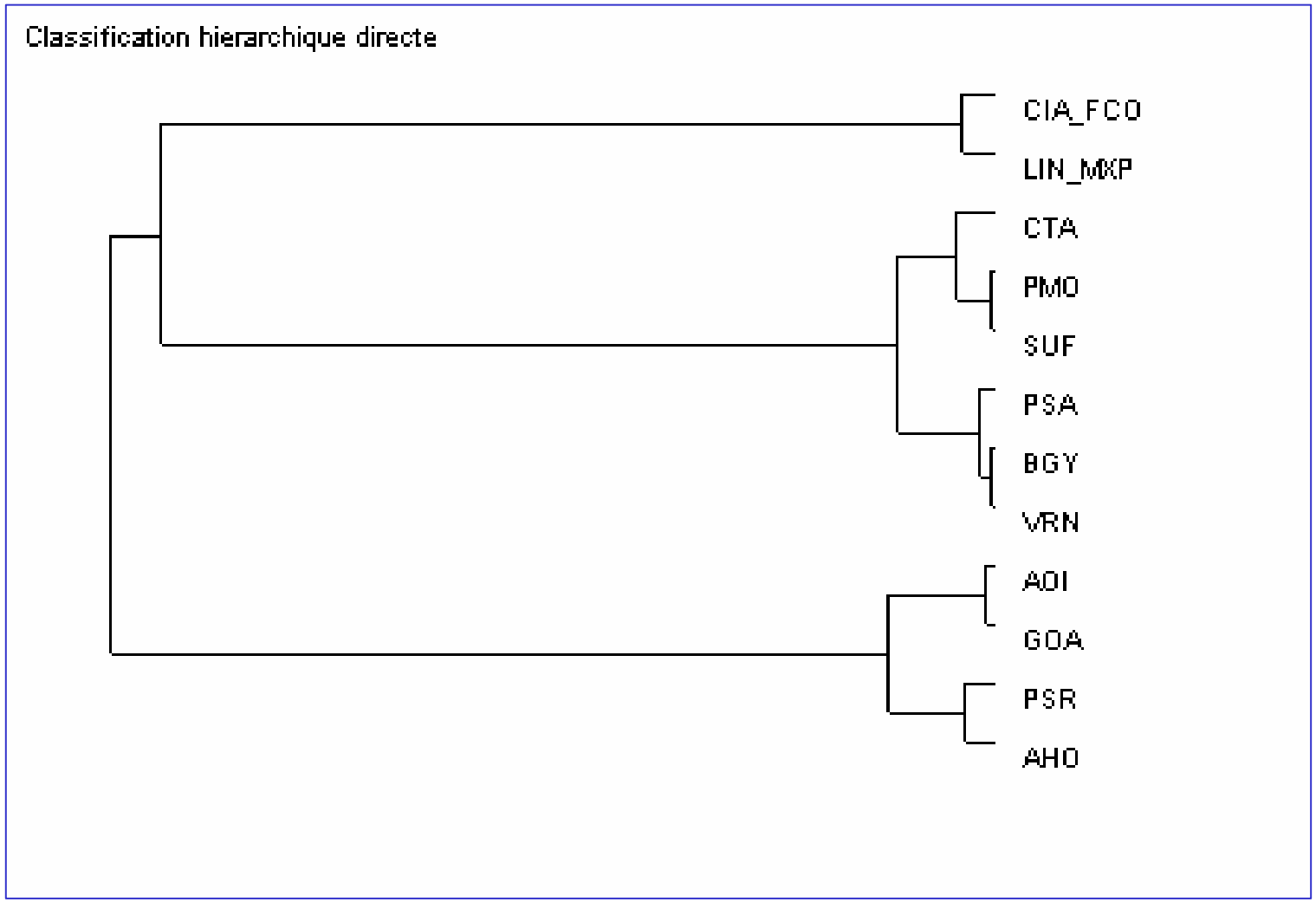


Hub airports seem to be more efficients (attended result)

The complete concession agreement seems to reduce capacity shortage.

➢ Empirical evidences

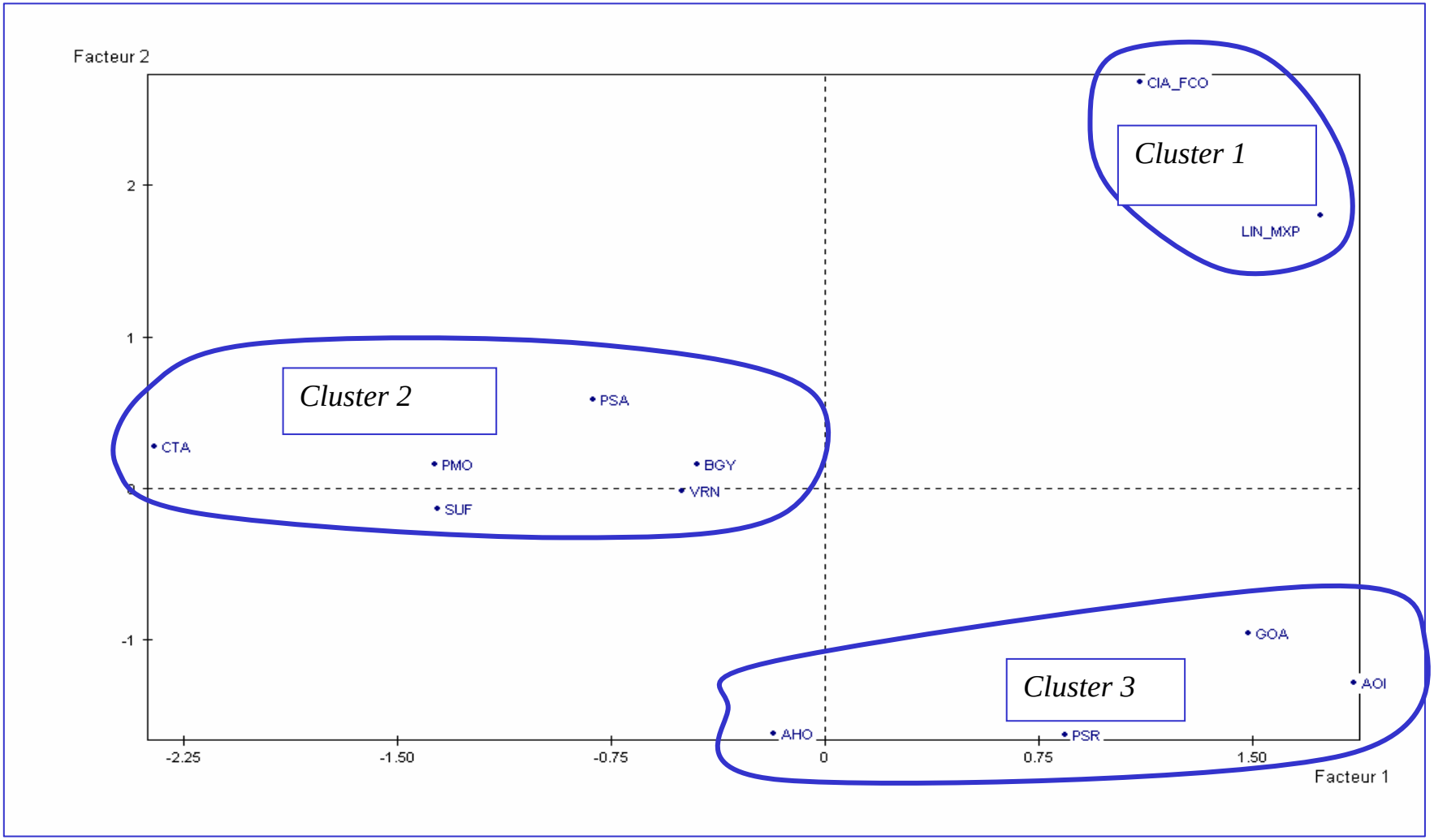
Step two: clustering analysis



Three clusters and…..

➢ Empirical evidences

Step two: clustering analysis

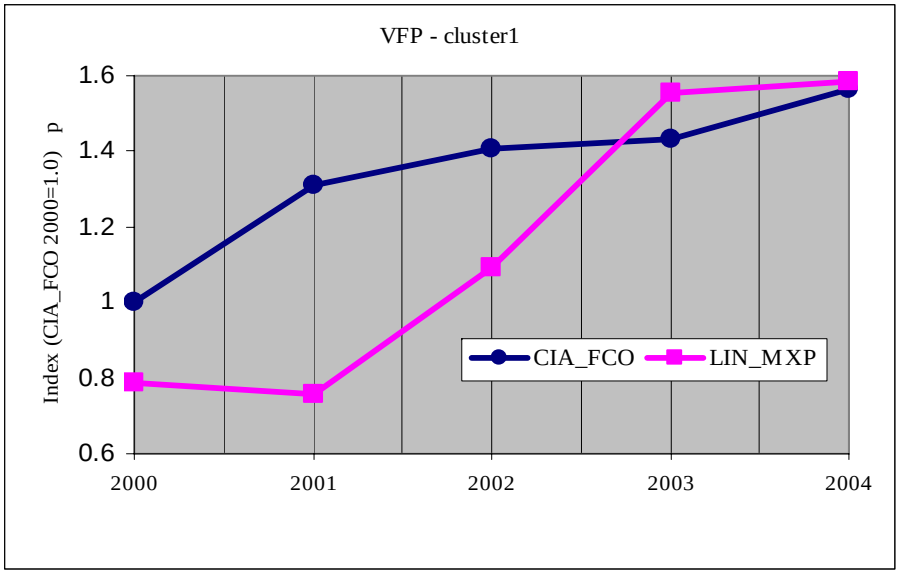


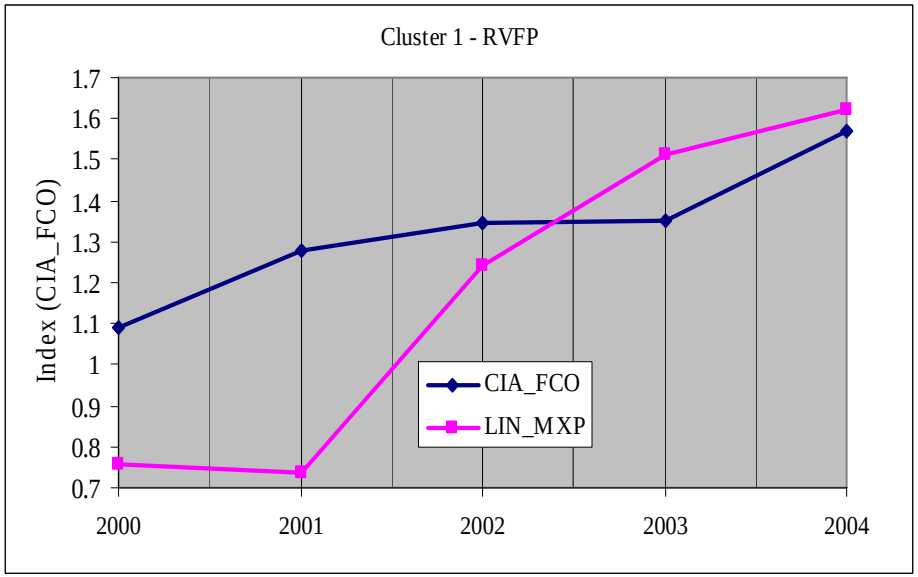
Their distribution

➢ Empirical evidences

Step three: measuring productivity

Cluster 1





the existence of a convergence process in the operating efficiency of the two italian airport systems,

the increase of operating efficiency after the privatisation and the liberalisation of the handling services,

Cluster 1

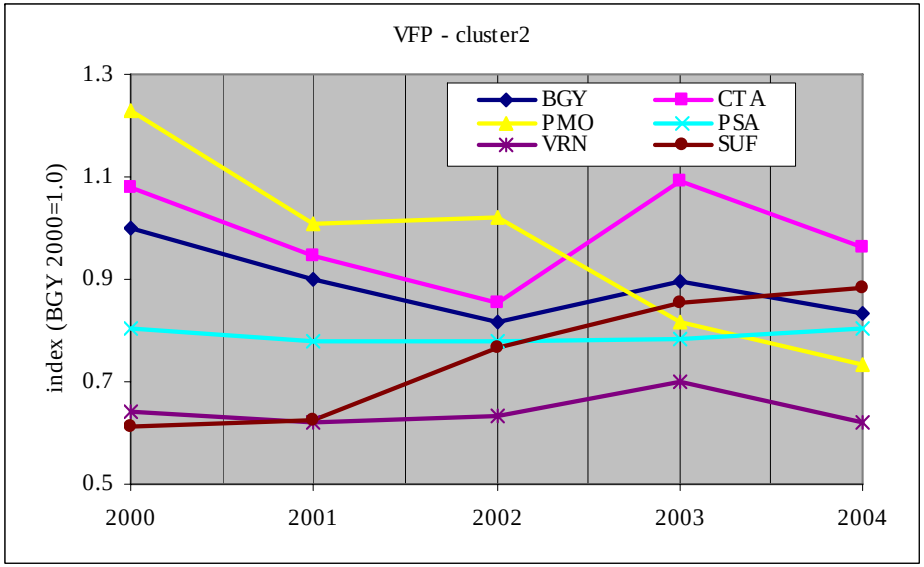
Variables	Dependent Variable	
	TFP	VFP
constant	-2.09 (0.030)	-2.727(0.030)
nastr	1.44 (0.000)	1.807 (0.00)
wlu	1.76 (0.006)	2.01 (0.011)
R^2	0.95	0.94
Adj. R^2	0.94	0.93
obs	10	10
BP-CW Heter. Test°	0.01 (0.99)	1.52 (0.46)

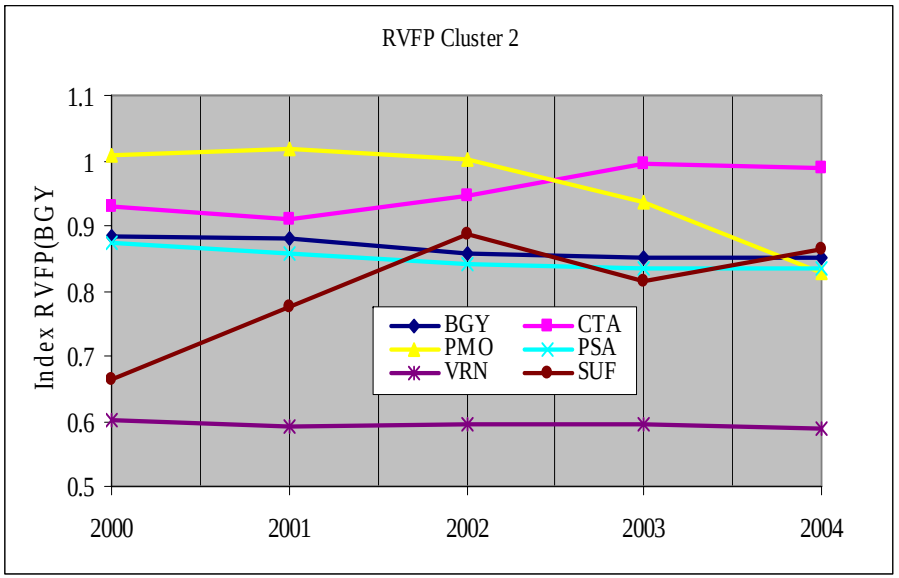
°Breusch-Pagan / Cook-Weisberg test for heteroskedasticity. H_0: Constant variance.

the positive and significant impact of:
non aeronautical share of total revenues (nastr),
work load unit (wlu)

➢ Empirical evidences Step three: measuring productivity

Cluster 2





existence of a convergence process in the operating efficiency of the 6 regional airports

leader position of Catania (CTA).

➢ Empirical evidences — Step three: measuring productivity

Cluster 2

Variables	Dependent Variable	
	TFP	VFP
constant	0.506 (0.000)	0.564 (0.000)
ac	0.189 (0.001)	0.259 (0.000)
F1		0.097 (0.022)
naz/int	0.024 (0.001)	0.040 (0.000)
wlu	0.144 (0.000)	
R^2	0.73	0.71
Adj. R^2	0.70	0.68
obs	30	30
BP-CW Heter. Test°	2.86 (0.41)	5.12 (0.36)

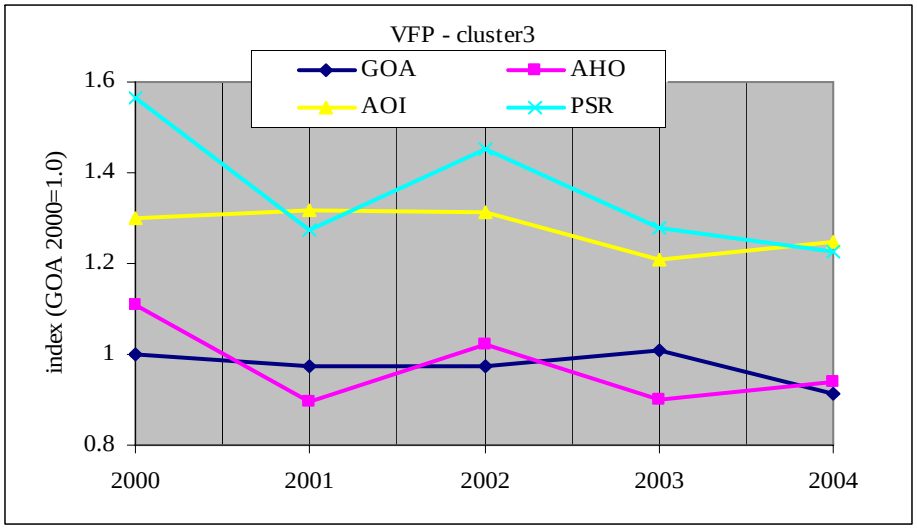
°Breusch-Pagan / Cook-Weisberg test for heteroskedasticity. H_0: Constant variance.

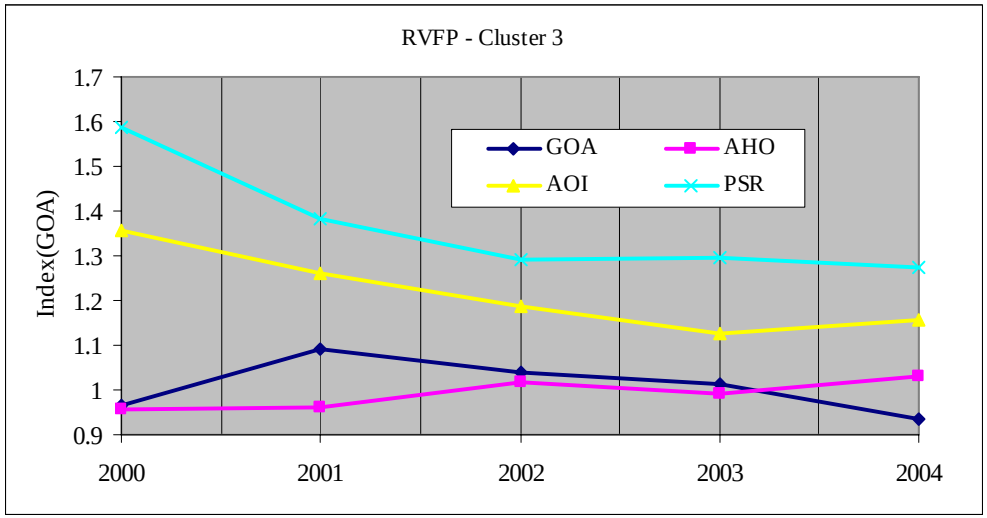
positive and significant impact of:
national/international (nat/int),
airport coordination (ac)

negative and significant impact of:
capacity shortage (F1)

➢ Empirical evidences Step three: measuring productivity

Cluster 3





poor performance of (GOA).

➢ Empirical evidences — Step three: measuring productivity

Cluster 3

Variables	Dependent Variable	
	TFP	VFP
constant	0.588 (0.00)	0.604 (0.000)
as/wlu	0.052 (0.00)	0.105 (0.000)
nars	0.310(0.000)	0.604 (0.016)
R^2	0.75	0.80
Adj. R^2	0.72	0.79
obs	20	20
BP-CW Heter. Test°	1.06 (0.79)	1.67 (0.64)

°Breusch-Pagan / Cook-Weisberg test for heteroskedasticity. H_0: Constant variance.

positive and significant impact of:
the ratio between the airport size and work load unit (as/wlu);
non aeronautical share of total revenues (nastr);

➢Concluding remarks

methodology

factorial and cluster analysis have allowed to reduce dissimilarity between airports and consequently

they have improved the efficiency of the regression results (no hetereschedasticity)

policy implication

the role played by an airport, hub or spoke, and the type of concession agreement owned have positive impact on their operating efficiencies.

the competition between the two italian airport systems has positive impact on their operating efficiency

major Italian regional airports seem suffering of capacity constraints

Concluding remarks

further developments

- the application of cluster analysis for each year of the analysis,
- the inclusion of new variables expressing the quality of airports infrastructure (i.e. ICAO parameters),
- try to obtain separate economic data for each airport included in the two airport systems (at the moment only physical data are available),
- compare the performance of the two Italian airport systems with the competing European hub (Frankfurt, Madrid, Vienna, etc.),
- compare the performance of the Italian regional airports with the other European ones.