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ABSTRACT

The aim of this work is the analysis of the operational efficiencies of the major Italian airports. The study is based on a cross-sectional, time series dataset of 14 Italian airports for the period 2000-2004. In the sample there are the two international airport systems of Rome and Milan, each composed by two airports, and ten regional airports. The analysis of the industry characteristics have pointed out that both structural and institutional factors cause an high degrees of dissimilarities among the 14 Italians airports. In this framework comparing the efficiency could be troublesome and misleading at the same time. Thus the methodological goal of the paper has been the application of two multivariate techniques, factorial and cluster analysis, in order to reduces dissimilarities and improve the results of the efficiency measures. The two multivariate techniques help in determining variables which mostly affect the airports operational efficiencies. The operational efficiencies have been estimated using non parametric models. In particular, the modified Torqvinst index has been employed to measure both Total Factor Productivity (TFP) and Variable Factor Productivity (VFP) indexes. Moreover, in order to remove the effects of the variables beyond the managerial control the residual Total Factor Productivity (RTFP) and Variable Factor Productivity (RVFP) indexes have been computed.

Keywords: Factorial analysis; Cluster analysis; Torqvinst index; Productivity.

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1. INTRODUCTION

The worldwide civil aviation deregulation process, started in US in 1978 (Airline Deregulation Act), has contributed to a steady demand growth in aviation markets and has deeply changed the industry characteristics. In this new environment, the achievement by airlines companies of higher level of productivities is one of the key factors to survive in the market. As a result the international air transport companies require a modern and efficient infrastructures (Martin and Roman, 2001). Therefore, starting from 1980 the policy pursuit by governments was to increase operational efficiency of the airports through a privatisation process (Hooper and Hensher, 1997). However, the privatisations have taken different formats/models in different countries. (Oum, et al., 2006). In Italy, this process has began in 1995 with the law n. 351 which has repealed the duty by the State to hold the control in the state-owned company. However, nowadays only three airports have a capital structure in which the ownership is hold by private investors: Catania, Rome Ciampino and Rome Fiumicino. The remaining major airports are characterized by a public-private ownership with a public (local municipality) majority. Leaving aside the capital composition of the airport a great source of dissimilarity in the Italian airports system stems from the difference in the airport governance forms. This source of heterogeneity will be probably mitigated in the following years when the major Italian airports will hold the same concession agreement. Finally, looking at the European experience, Italy is the sole European country where the Government has brought into direct rivalry two hubs: Rome and Milan. Thus, comparing the performance of the Italian airports seems to be a difficult task since how it has been pointed out by Kamp Müller Niemeier (2005) "airport benchmarking is challenging because of the so called 'uniqueness' of the airports, as operation of every airport slightly differs from another". Even if there is a consolidated literature on airports efficiency comparison (Gillen and Lall, 1997; Sarkis, 2000; Martin and Roman, 2001; Pels. et al.2001) there are not study on the performance evolution of the Italian airports. International analysis have just tackled two Italian airports those of Milan and Rome. Therefore the present paper represents the first study of the Italian airport efficiency. The main goal of the paper is the introduction of two methodologies, factorial analysis and cluster analysis, which allows to reduce airport dissimilarity before performing the efficiency analysis. In section 2, the market structure of the Italian airport system is described. Section 3 presents the governance forms of the Italian airports. In section 4, the methodology has been outlined; first the characteristics of the factorial and of the cluster analysis techniques have been discussed, then the Total Factor Productivity measures based on the Tornqvist index have been introduced. Sections 5 and 6 show the empirical results. Section 7 contains some concluding remarks.

2. INTRODUCTION INTO ITALIAN AIRPORT MARKET STRUCTURE

The Italian airport system is composed by about 37 airports. In the present analysis data for 14 airports, over the period 2000-2004, have been collected[1]. The airports distribution is reported in figure 1.

Figure 1: Airport distribution.

The airports included in the analysis cover about the 70%, 77% and 75% of the total national traffic, total international traffic and total work load unit (wlu) respectively. The are 2 airport systems and 9 regional airports. The first airport system is composed by the hub of Rome Fiumicino (FCO) and by Rome Ciampino (CIA). In the second one, there are three airports: the hub of Milan Malpensa (MPX), Milan Linate (LIN) and Bergamo (BGY). The 9 regional airports are: Alghero (AHO), Ancona (AOI), Catania (CTA), Genova (GOA), Palermo (PMO), Pisa (PSA), Pescara (PSR) and Verona (VRN). The traffic decomposition between the two airport systems and the 9 regional airports is reported in table is reported in table 1.

[1] The list of the airports and their code is reported in appendix.

	national (%)	international (%)	transit(%)	cargo(%)	wlu(%)
Aiport System 1					
Rome Fiumicino Hub (FCO)	26.69	27.39	41.39	23.98	27.20
Rome Ciampino (CIA)	0.061	2.57	1.23	2.49	1.51
Tot. (1).	26.75	29.96	42.62	26.47	28.71
Airport System 2					
Milan Malpensa Hub (MPX)	9.09	29.04	12.95	44.05	21.20
Milan Linate (LIN)	11.81	4.48	0.12	3.36	7.72
Bergamo (BGY)	0.74	3.10	1.45	14.82	2.95
Tot. (2)	21.62	36.62	14.52	62.23	31.87
Tot. *(1)* + Tot. *(2)*	48.30	66.58	57.14	88.71	60.58

Table 1. The role of the Italian airport systems

From the analysis of table 1 it is immediate to observe that most of the international traffic in Italy is served by the two airport systems. Looking at the national traffic, the dominance position is reduced, but not eliminated. This is clearly the result of the hub and spoke structure adopted by Italian national flag Alitalia. In what it follows, since Milan Malpensa and Linate airports are managed by a different company from that one of Bergamo, the data on the latter have been separately considered. Another aspect which has to be taken into consideration is the characteristics of the demand served by the Italian airports. Table 2 shows the demand evolutions for the 14 Italian airports over the period 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

Table 2. Demand evolutions.

The analysis of table 2 confirms, for the Italian airports, the worldwide tendency: the increase of the traffic levels. The raise of the traffic in the regional airports has been lead by the low cost airlines which have mainly chosen these airports for their connection point to point. Moreover, some airports are characterised by the presence of high levels of seasonality which are caused by tourism.

3. THE GOVERNANCE FORMS OF THE ITALIAN AIRPORTS

The governance structure of the of Italian airport system is composed by four main stakeholders:

The Ministry of Infrastructures and Transportations;

- ENAC (Ente Nazionale Aviazione Civile): Italian Civil Aviation Authority;
- Assoclearance and Italian Coordination Committee;
- airport management companies;

The Ministry of Infrastructures and Transportations approves the airport masterplans and exerts functions of vigilance and control on ENAC activities. ENAC, a public authority, has the trusteeship for the airports side by the State and exerts activities for technical and economic control. Moreover it also directly manages airport activities. Finally ENAC, is the authority which makes the tariffs of the airport concessions and of the charges for take-off, landing, aircraft parking, security services and passengers. The charges are calculated taking into account several parameters. In particular, the analytical formula includes the inflation rate, the total factor productivity growth rate, the traffic level and its expected growth rate, the average level of the European charges, a recovering factor to compensate the extra costs due to the infrastructure investments, a parameter measuring quality and environmental standards reached, and finally a parameter measuring the characteristics of the airport structures. The charges do not include parameters which consider the existence of cycles in the air-transport demand evolution (see table 2 in section 2). Table 3 shows the mean, the variance and the variation coefficient of passenger, landing and take-off charges for the 14 airports.

Airport (IATA code)	Unit charge for passenger		Landing and take-off charge			
	UE	Extra UE	UE		Extra UE	
			<25 tons	more	<25 tons	more
mean	4.702	7.440	1.082	1.548	1.934	2.424
variance	1.079	0.133	0.270	0.342	0.036	0.048
variation coef.	0.229	0.017	0.249	0.221	0.018	0.019

Table 3. Passenger, landing and take-off charges.

Assoclearance is the coordinator of the Italian Coordination Committee[2]. It is an association established by the Italian government as a legal entity and as a non-profit organization for the purpose of executing the tasks foreseen by European Regulation and following, on the subject of airport slot assignments, “common rules for the allocation of time slots in coordinated airports”. In particular, the criteria followed in the preliminary phases of slot allocation are the following:

1. when the air carrier request is meet:
   1.1. safeguard of historical rights acquired by carriers (“Grandfather Rights”, article 8 of EU Regulation 95/93);
   1.2. priority shall be given to commercial services (scheduled and non-scheduled services);

[2] Article 5 of EU Regulation 95/93 and Decree of the Ministry of Transport 44/t of 4th July. The statutory members of the Committee are the following: The airport authorities (Government bodies), the air carriers using the airport most, the organizations representing air carriers, air traffic control representatives, the airport management company, assoclearance.

2. in cases where requests cannot be met:
    2.1. the coordinator shall provide the reasons for the refusal and shall propose as an alternative the closest time slot;
    2.2. provided that a request in advance is made to the coordinator, and subject to the Coordinator's verification and authorization, time slots may be freely exchanged among air carriers or transferred by a given air carrier to one route to another, or replace one type of service with another.

The Italian airports are classified by the Coordination Committee in three groups:

- non coordinated airport *(level 1)*
- schedules facilitated airport *(level 2)*
- fully coordinated airport *(level 3)*

A non coordinated airport is an airport where slots requests may be always accommodated at the time requested, and therefore there are no bottlenecks in the overall demand. A schedules facilitated airport is an airport where the existence of congestion, in some time of the day or the week, could be solved by a voluntary agreement between airline companies. A fully coordinated airport is an airport where there are no possibility to increase the capacity in the short term in order to respond at all times to demands from air carriers. For these airport slots are allocated by the Assoclerance. Table 4 shows the coordination level for the 14 airports:

airports (IATA code)	non coordinated *(level 1)*	scheduled facilitated *(level 2)*	fully coordinated *(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)			

Table 4. Airporst classification.

The airport governance forms can be classified in four alternative groups according to the different concession agreements:

complete concession;

partial concession;

partial–precarious concession;

direct.

The holder of a complete management concession is responsible for the provision of all airport services (air side and landside) and collects all revenues derived from airport operations, including all receipts pertaining to the State. The airport management companies are also responsible for the maintenance and the development of the infrastructures. Before 1993, law n. 537/93, the "complete concession" has been guaranteed to a restricted number of airports by special laws[3]. Moreover, law n. 537/93 gives to the management companies the right to use airport side for the services provision for a period of 40 years. An airport management company, holding an "partial concession", provides the management of the airport terminal building and his pertinences. Revenues come from airport rights for passengers and goods (boarding and disembarking services) and from commercial activities. The flight infrastructures, the hangars and the fuel services are managed by the State through ENAC. A "Partial-precarious concession" implies the management of the airport terminal building and his pertinences. However, it reduces the revenues to the commercial ones. The remaining infrastructures and services are managed by the State through ENAC. Both "partial and partial-precarius concession" allow to the management companies to exert their rights on the airport side for a maximum tenure of 20 years. With the "direct" governance ENAC provides all the services both for the land and the air side. However commercial activities could be also granted in concession to private companies. As far as the capital structure composition of the management companies is concerned the law n. 351/1995 has repealed the duty by the State to hold the control. But, at the moment only few airports have been fully privatised: Milan, Rome and Catania. Up to now, after a trial period, those companies that have fulfilled the standard required by ENAC are waiting for a Ministry of Infrastructures and Transportations decree in order to hold an 40 years concession. The concession agreements and the capital composition is showed in table 5.

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)		■			

Table 5. Concession agreements and capital composition.

[3] Genova Law n. 156/1954; Milan Linate Law n. 194/62; Milano Malpensa n. 449/85; Torino, Law n. 914/65, n. 736/86, n. 187/92; Roma Fiumicino Law n. 775/73 and Roma Ciampino Law n. 985/77.

Figure 2 depicts the various relationships between the main agents which constitutes the Italian airports governance system.

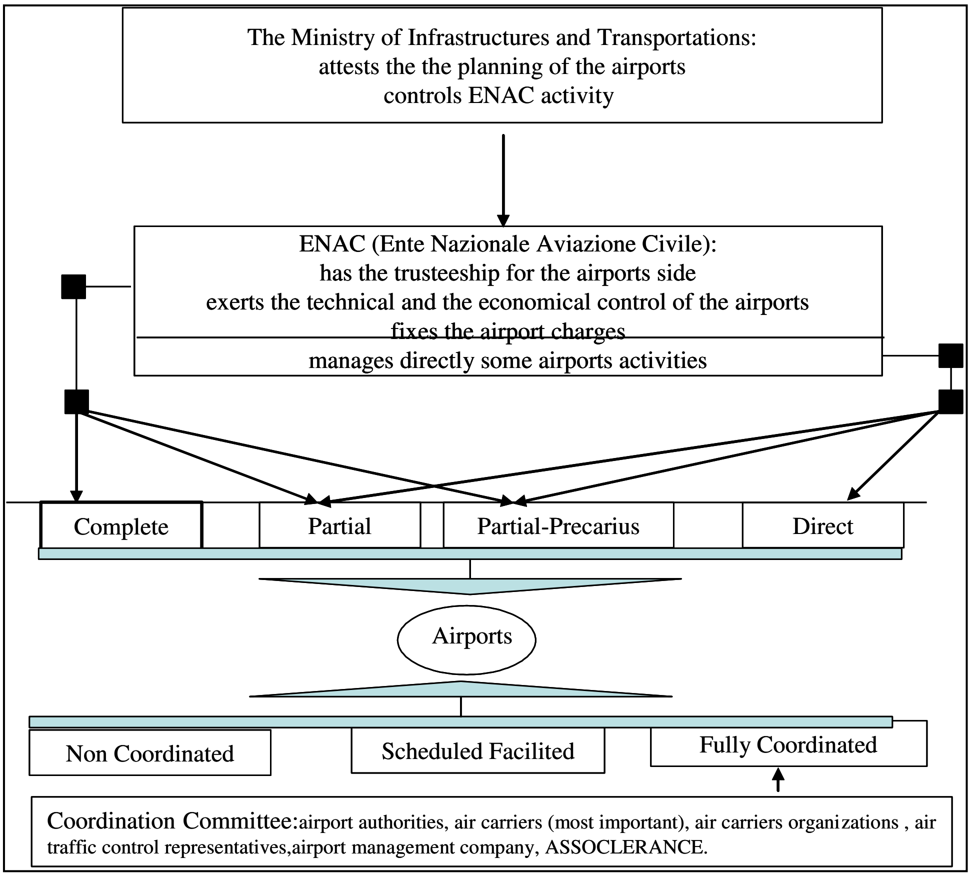

Figure 2. Italian airports governance system.

4. METHODOLOGICAL APPROACH

4.1. *Grouping Italian airports.*

Section 2 and 3 suggest that the Italian airports are characterized by an high degree of heterogeneity due both to structural - hub or spoke, localisation, demand characteristics, etc.- and to institutional factors. Moreover, the literature has pointed out that service activities, non directly related to aeronautical ones, have increased their importance for the international airports (Oum et al. 2006). However, such non core activities could still remain marginal for most of regional airports. Therefore, in order to compare the efficiency level among homogeneous groups of airports two multivariate techniques have been employed: the factor and the cluster analysis. The basic purpose of the factor analysis is to create the minimum number of uncorrelated variables, called underlying factors, with the hope that these new variables explain the maximum amount of the overall variance of the observed ones. The factors, which are linear combinations of the observed variables, can be interpreted in economic terms. Following the paper by Voegel (2005) a set of variables describing the airport characteristics has been employed. The variables, their means, standard deviations and variation coefficients are summarized in tables 6 and 7.

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

Table 6. Economic indicators.

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			

Table 7. Physical and structural indicators.

Since data cover a period of five years the factorial and the cluster analysis have been conducted on the average values of the variables defined in tables 6 and 7. Following the standard procedure only the continuous variables exerting low level of correlation, the so called active, have been employed in the factorial analysis. Moreover, the dicotomic and a sub set of correlated variables have been used as illustrative to label the factors. Then, the factors have been utilised to group airports through the cluster analysis. It is well known that, the basic question posed for a cluster analysis is whether it is possible to devise a classification or grouping scheme that will allow partitioning of the units into classes or groups, called clusters, so that the units within a class or group are similar to one another while those in distinct classes or groups are not similar to those in the others groups. So the main objective of the cluster analysis has been to obtain groups of airports which can be compared. It is worth to note that in the present paper, departing from the paper by Sarkis and Talluri (2001), the cluster analysis has been employed before computing the efficiency measures.

4.2. Measuring Italian airports efficiency.

Total factor productivity (TFP) is a widely used measure of productivity. TFP is defined as the amount of aggregate ouput produced by a unit of aggregate input. In the present paper the measure of the total factor productivity is obtained through the modified Tornqvist index (Cave, Christensen and Diewert; 1982). Thus, let y_{ij} and p_{ij} respectively be, the quantity and the price of output *i (i=1,…,N)* at time *j (j=s,t)* then Tornqvist output index, in its log-form, is given by:

$$\ln Y_{st}^{T} = \sum_{i=1}^{N} \left\langle \frac{w_{is} + w_{it}}{2} \right\rangle \left(\ln y_{it} - \ln y_{is} \right) \qquad (1)$$

where,

$$w_{ij} = \frac{p_{ij}\, y_{ij}}{\sum_{i=1}^{N} p_{ij}\, y_{ij}} \qquad \begin{matrix} i = 1,\dots,N \\ j = s,t \end{matrix} \qquad (2)$$

are the revenue shares. Similarly let x_{kj} and p_{kj} be the quantity and the price of input *k (k=1,…,,M)* at time *j(j=s,t)*, then it is possible to define Tornqvist input index as:

$$\ln X_{st}^{T} = \sum_{k=1}^{M} \left\langle \frac{w_{ks} + w_{kt}}{2} \right\rangle \left(\ln y_{kt} - \ln y_{ks} \right)$$

where:

$$w_{kj} = \frac{p_{kj} y_{kj}}{\sum_{i=1}^{N} p_{kj} y_{kj}} \qquad \begin{matrix} k = 1,\dots,M \\ j = s,t \end{matrix}$$

represent the cost shares.

At this point the TFP index is given by:

$$\ln TFP_{st} = \frac{\ln Y_{st}^{T}}{\ln X_{st}^{T}} \qquad (3)$$

Which can be written as follows:

$$\ln TFP_{st} = \frac{1}{2}\sum_{i=1}^{N}\left(w_{is} + w_{it}\right)\left(\ln y_{it} - \ln y_{is}\right) - \frac{1}{2}\sum_{k=1}^{M}\left(v_{ks} + v_{kt}\right)\left(\ln x_{kt} - \ln x_{ks}\right) \qquad (4)$$

The index (4) is not transitive for a change in the base period[4]. Cave, Christensen and Diewert(1982) have modified relation (4), obtaining this multilateral generalization:

$$\begin{aligned}\ln TFP^{*}_{st} = &\left\langle \frac{1}{2}\sum_{i=1}^{N}\left(w_{it} + \overline{w}_{i}\right)\left(\ln y_{it} - \overline{\ln y_{i}}\right) - \frac{1}{2}\sum_{i=1}^{N}\left(w_{is} + \overline{w}_{i}\right)\left(\ln y_{is} - \overline{\ln y_{i}}\right)\right\rangle - \\ &\left\langle \frac{1}{2}\sum_{k=1}^{M}\left(v_{kt} + \overline{v}_{k}\right)\left(\ln x_{kt} - \overline{\ln x_{k}}\right) - \frac{1}{2}\sum_{k=1}^{M}\left(v_{ks} + \overline{v}_{k}\right)\left(\ln x_{ks} - \overline{\ln x_{k}}\right)\right\rangle\end{aligned} \qquad (5)$$

where:

$$\begin{aligned}\overline{\ln y_{i}} &= \frac{1}{T}\sum_{h=1}^{T}\ln y_{ih} \\ \overline{\ln x_{k}} &= \frac{1}{T}\sum_{h=1}^{T}\ln x_{kh} \qquad i = 1,\ldots,N \\ \overline{w}_{i} &= \frac{1}{T}\sum_{h=1}^{T} w_{ih} \qquad k = 1,\ldots,M \\ \overline{v}_{k} &= \frac{1}{T}\sum_{h=1}^{T} v_{kh}\end{aligned} \qquad (6)$$

In the present paper TFP values have been obtained through the free software TFPIP (Coelli; 1997). Following the international literature, the outputs included in the model are: the number of passengers, the volume of air cargo, the number of aircraft movements and revenues from non aeronautical services. For the revenues from non aeronautical services an output index is constructed by deflating the non aeronautical revenues by the consumer price index. On the input side, three inputs are considered: labour, capital and soft costs. Labour is measured by the number of full-time equivalent employees. Capital is proxied by the runways area. The cost of capital, following the paper by Parker (1999), has been estimated as an annual rental based on a rate of 8 per cent each year applied to the net capital stock employed. Soft costs include all expenses not directly related to capital and labour. For the soft costs an output index has been constructed by deflating soft costs by the consumer price index. By changing the input composition is possible to determine the so called variable factor productivity index (VFP). In particular, the capital variable input has been carried out by the relation (5). The above choice is motivated by the fact that long-term investment decisions are generally beyond airport managerial control (Oum et al. 2006, Kamp et al.2005). TFP and VFP are "gross" productivity measures because they should be influenced by numerous factors beyond managerial control such as: airport location, air traffic composition, governance form, etc. Therefore, residual total factor productivity (RTFP) and residual variable factor productivity (RVFP) have been estimated by regressing TFP and VFP on a specific set of variable measuring factors outside managerial control.

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[4] For any three periods *s*, *t*, *r*, an index I_{st} is transitive if: $I_{st} = I_{sr} \times I_{rt}$

5. EMPIRICAL RESULTS

The first step in the factor analysis is the study of the correlation matrix among the continuous variables defined in tables 6 and 7. From the correlation analysis it appears, as attended, that most of variables present an high correlation degree (the correlation matrix is reported in appendix). Thus the original variables set has been restricted to following: work load unit *(wlu)*, the asset utilisation, *(au)*, non aeronautical share of total revenue *(nastr)* and return on capital employed *(roce)*. At this point, in order to interpret in economic terms the two first factors, explaining about 83% of the total variance, the correlations between the factors and both active and continuous illustrative variables have been examined. In particular, the following illustrative variables have been considered: the ratio between national and international traffic *(nat\int)*, aeronautical revenues per wlu *(arpw)*, commercial revenues per passenger *(crp)*, airport size *(as)* and total cost per wlu *(tcw)*. The relations are showed in table 8 and in figure 3.

Variables	Factors	
	F1	F2
Actives		
wlu	0.4	0.85
asset utilisation *(au)*	-0.89	0.00
non aeronautical share of total revenue *(nastr)*	0.87	-0.16
roce	-0.23	0.91
illustratives		
national\international *(nat\int)*	-0.61	-0.16
total cost\wlu *(tcw)*	0.74	-0.36
fixed assed turnover *(fat)*	-0.67	-0.03
aeronautical revenue\wlu *(arpw)*	0.51	0.11
commercial revenues\pax *(crp)*	0.78	-0.04
airport size *(as)*	0.44	0.83

Table 8. Factor correlations matrix.

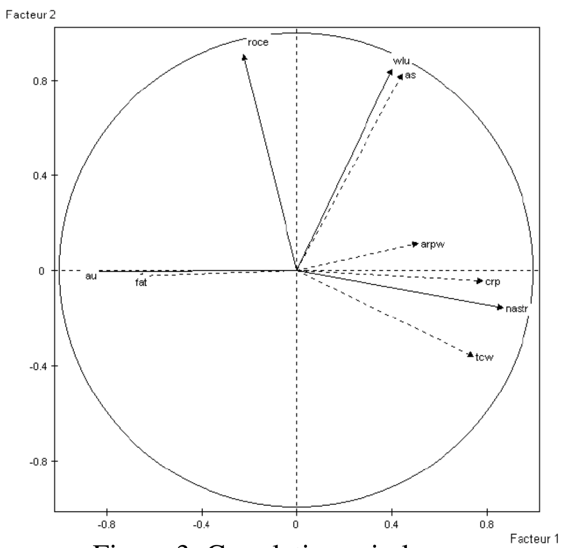

Figure 3. Correlations circle.

The first factor, *F1*, when is negative it is completely explained by the variable asset utilisation. Thus this factor is likely a measure of the degree of capacity utilisation of the airports. On the contrary the positive part of the axe can be interpreted as a measure of the revenue composition for its high correlation degree with the non aeronautical share of total revenue. The second factor, *F2*, seems to measure the economic airport efficiency: the positive impact of *roce* connected to negative impact of the *total cost per wlu*. Moreover, the positive relation between the factor and the variable wlu highlights as the economic performance is connected to the airport output level. In other terms the above relation indicates that one of the factors that allows to reach a better economic performance is represented by the airport capacity to exploit scale economies. Thus this is the confirmation of one of the Porter finding about the relation between firm dimension, strategies and profitability. Further information can be derived by plotting the dicotomic (illustrative) variables on the two factorial axes (see figure 4).

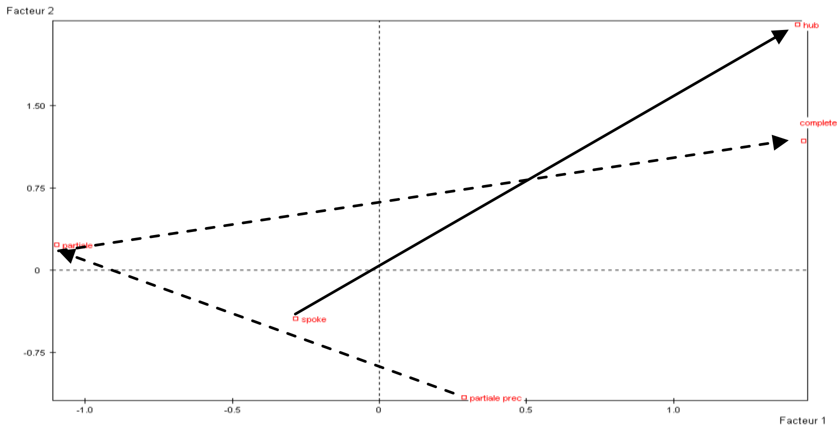

Figure 4. The dicotomic variables

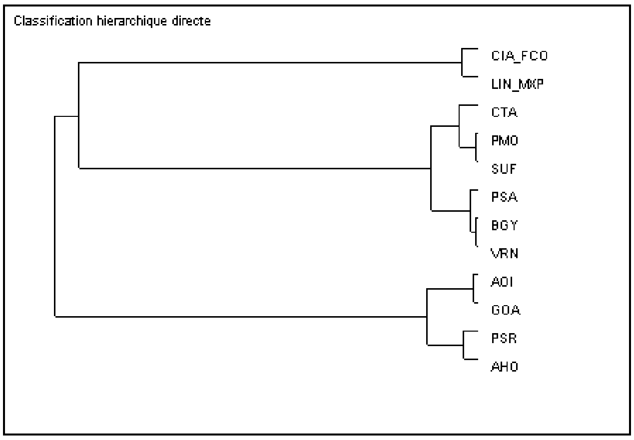

Figure 5. Airports dendrogram.

The above figure confirms the role played by the airport in the system, *hub vs spoke*, in determining its economic efficiency. A similar impact is produced by the concession agreements hold by the airport management companies. In particular, a complete concession agreement seems to reduce the capacity shortage and to increase overall economic efficiency. Once the factors have been individuated a cluster analysis has been carried out[5]. The cluster analysis employed is the hierarchical clustering technique. With this method the observed data points are grouped into clusters in a nested sequence of clusterings. Figure 5 depicts the hierarchical tree diagram, the so called dendrogram for the 12 airports[6]. The cut of highest steps in dendrogram allows to identify the number of clusters.

Figure 6 shows the cluster distribution respect to the two factors.

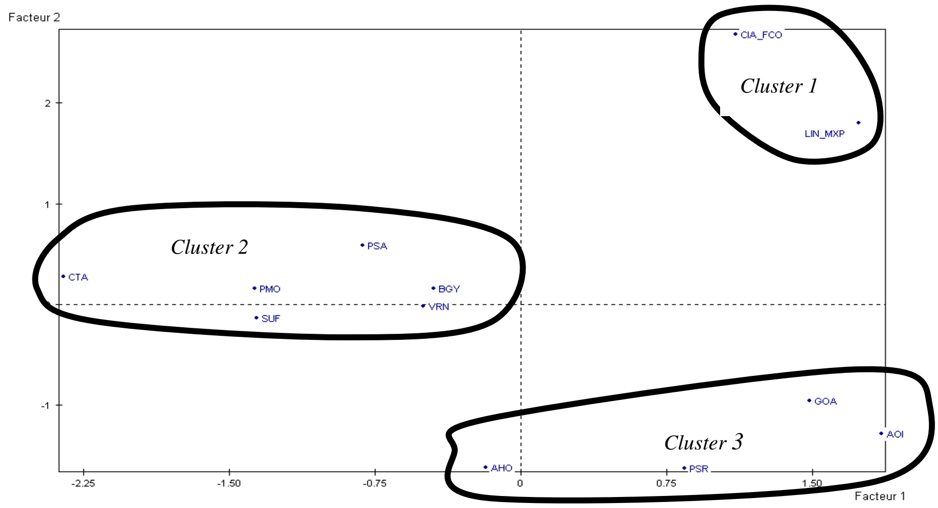

Figure 6. Cluster distribution.

Now, in what it follows the three cluster are described with respect the active and the illustrative variables.

cluster 1

The first cluster is composed by the two Italian hubs CIA_FCA (Roma, Ciampino-Fiumicino) and LIN_MXP (Milano, Linate-Malpensa).

variables	*t test (probability)*	*mean*		*standard deviation*	
actives		*cluster*	*general*	*cluster*	*general*
wlu	3.29 (0.0)	29,816,988	6,560,870	110,217	10,473,660
au	-1.26 (0.10)	0.03	0.05	0.01	0.02
nastr	0.84 (0.20)	0.37	0.31	0.02	0.11
roce	1.65 (0.05)	0.12	0.05	0.04	0.06
illustratives					
nat\int	-1.02(0.153)	0.72	2.05	0.13	1.93
arpw	0.36(0.361)	0.09	0.08	0.00	0.02
crp	0.79(0.215)	0.05	0.04	0.00	0.03
as	3.29(0.00)	1722.6	467.45	102.4	566.35
tcw	-0.31(0.380)	0.11	0.12	0.00	0.04

Table 9. Cluster 1 descriptive variables.

[5] By performing factorial and cluster analysis for ecah year there are not changes in the number and composition of the clusters.

[6] The airports are 12 because it has not been possible to separate economic data for Rome Ciampino, Rome Fiumicino and Milano Linate and Malpensa.

These two airport systems have a complete concession since 1962 and 1973 respectively. They are international airports and are the biggest in terms of both land and air side. The Rome airport system is controlled by private companies while the Milan by a public one. The high average value of *roce* (see table 9) registered in this cluster, if compared with the average value for all the airports, seems to indicate, for the two hubs, a better management efficiency in employing capitals to generate revenues.

Cluster 2

In the second cluster there are six airports that serve as spokes in the Italian airport system. Five airports hold partial concession agreement (BGY, CTA, PMO, PSA, VRN) and one holds a partial precarious one (SUF). Moreover, the capital structure of CTA is characterized by a private control while for the remaining airports the capital structure are mixed public-private with a public majority. It is worth to note that most of public control is exercised by the local municipalities. Looking at the airport characteristics (see table 10) it is immediate to observe their high degree of capital productivity. The high degree of capital utilisation should be connected to the fact that five airports hold a partial concession which not aloud to the management companies to develop the flight infrastructures, leaving this activity to ENAC. But, the austerity policy adopted by Italian government during the past years to reduce budget deficits and reining in the national debit has slackened investments in the infrastructure development included the airports ones.

variables	*t test (probability)*	*mean*		*standard deviation*	
actives		*cluster*	*general*	*cluster*	*general*
wlu	-1.21 (0.11)	2,727,689	6,560,870	1,145,769	10,473,660
au	2.16 (0.01)	0.07	0.05	0.02	0.02
nastr	-2.62 (0.004)	0.23	0.31	0.04	0.11
roce	1.46 (0.07)	0.08	0.05	0.04	0.06
illustratives					
nat/int	1.17(0.12)	2.73	2.05	2.41	1.93
arw	-0.42(0.337)	0.08	0.08	0.02	0.02
crp	0.79(0.215)	0.05	0.04	0.00	0.03
as	-1.38(0.08)	232.00	467.45	80.49	566.35
tcw	-1.80(0.036)	0.09	0.12	0.02	0.04

Table 10. Cluster 2 descriptive variables.

The cluster should be further divided taking into account the traffic composition. In fact, while the airports of CTO, LMP and PMO, located in the south of Italy, are characterized by national traffic the airports of PSA, BGY and VRN, located in the middle and in the north of Italy respectively, present an international orientation. The international vocation of PSA, BGY and VRN is mainly due to the presence of low cost and national flag companies which exert connection point to point from Italy to the European countries.

Cluster 3

The last cluster is the most heterogeneous. It is composed by four airports: AHO, AOI, GOA, and PSR. GOA holds a complete concession agreement, while the remainders hold a partial precaurius one. All the airports have a private-public ownership with a public majority. The airports are characterized by economic inefficiency and by international orientation (see table 11).

variables	*t.test (probability)*	*mean*		*standard deviation*	
actives		cluster	general	cluster	general
wlu	-1.32 (0.09)	682,583	6,560,870	315,743	10,473,660
au	-1.29 (0.10)	0.04	0.05	0.01	0.02
nastr	2.12 (0.02)	0.41	0.31	0.10	0.11
roce	-2.85 (0.00)	-0.02	0.05	0.03	0.06
illustratives					
nat/int	-0.43(0.33)	1.69	2.05	0.85	1.93
arw	0.17(0.43)	0.08	0.08	0.02	0.02
crp	1.37(0.09)	0.05	0.04	0.04	0.03
as	-1.14(0.13)	193.05	467.45	33.67	566.35
tcw	2.15(0.02)	0.16	0.12	0.05	0.04

Table 11. Cluster 3 descriptive variables.

The position of two airports, AOI and GEO, in the right down corner of figure 6, is mainly due to the high level of revenues from non aeronautical activity. In particular, GOA position is connected to its concession agreement which allows to exploit revenues from commercial activities. For Ancona airport (AOI) the position can be explained by the increase of revenues stemming from fueling services. This airport is a military one and serves as base for the English RAF operation in the Balcanic region.

To sum up the previous analysis confirm some evidences stemming from the international literature. In particular, the type of the governance form, the role played by the airport in the network (hub or spoke), and the relevance of the traffic volume and its composition seem to affect airport economic efficiencies. Therefore, it should not be appropriate to compare performances of airports characterized by such dissimilarities.

6. **EFFICIENCY ANALYSIS**

6.1. TFP and VFP evolutions

In this section the evolutions of TFP and VFP, defined in section 4, are showed.

Cluster 1.

The analysis of TFP and VFP (figures 7 and 8) suggests that both airports have increased their efficiency during the past five years.

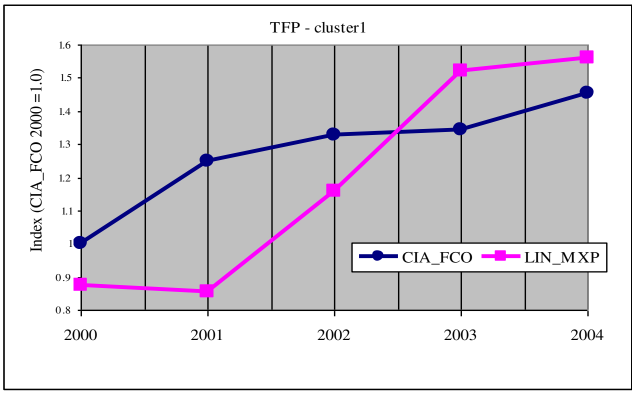

Figure 7. Cluster 1. TFP evolution.

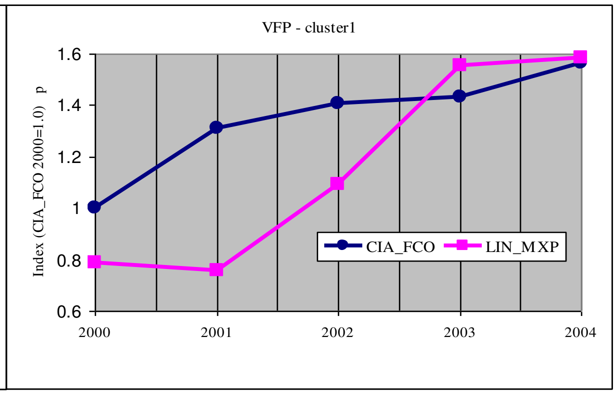

Figure 8. Cluster 1. VFP evolution.

The increase in the operational efficiency of Milan airport system in 2001 and of Rome airport system one year before is the result of the application of the European Council Directive 96/67/EC. In fact, the rapid growth of the efficiency measures for LIN_MXP, management by SEA a public-private company, from 2001 can be explained by the fact that up to 2001 all ground handling services were provided by SEA and TWA. To date, the application, passenger handling is provided by SEA Handling and by four private handlers: ATA handling, ARE Group, Globerground Italia and ICTS Italia. Ramp services are provided by SEA handling and ATA handling. Rome airports managed by ADR, a private company, externalized handling activity in 1999 when it created Aeroporti di Roma Handling. To date about 34% of passenger handling services are provided by Aeroporti di Roma Handling, the remaining market share is served by numerous companies. As far as the ramp services is concerned there is a similar situation with only two providers, Alitalia Airports and EAS (a subsidiary of the Italian AirOne flight company), which serve a residual market share respect to Aeroporti di Roma Handling. The increase of the slope of both TFP and VFP lines after the externalization and the liberalisation of the handling services seems to indicate the positive impact that such a policy have had on airports operating efficiency. Looking at the VFP evolution, which is more robust to TFP in measuring the effects of managerial control (Oum et al.; 2006), the figure shows as the two competing Italian airports system are converging to same level of efficiency.

Cluster 2.

The second cluster is composed by six regional airports. The evolution of TFP and VFP are shown in figures 9 and 10 respectively.

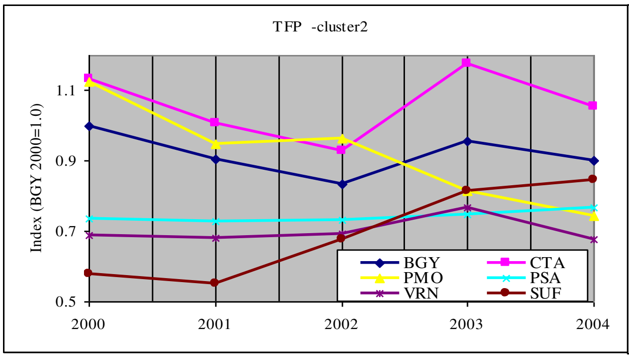

Figure 9. Cluster 1. TFP evolution.

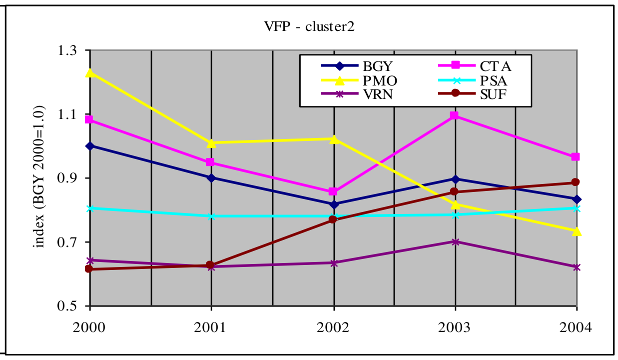

Figure 10. Cluster 1. VFP evolution.

The evolution of the two indexes suggests the presence of a possible convergence process among the operating efficiencies of the six airports. In particular, the VFP analysis highlights, as attended, that by excluding the capital investment in the measurement the spread between the airports performance is reduced. Among the airports PMO has been characterized by a steadily efficiency lost. For the airport, located in Sicily in the south of Italy, the values of TFP and VFP are quite similar suggesting that, during the period 2000-2004, the output growth (see table 2 in section 2) has not been followed by an infrastructures expansion. An opposed pattern has been registered by SUF, an airport located in the south of Italy too, where the traffic increase has allowed a better infrastructures exploitation. It is worth observing that BGY, CTA and VRN have reduced their efficiency after 2003. For BGY, the third component of the Milano Linate-Malpensa airport system, the increase of *wlu*, about 134% from 2000 to 2004 (about 90% from 2002 to 2004), has probably lead the airport to operate with near decreasing return to scale. Similar reasons can be advocated for VRN and CTA[7]

Cluster 3.

In the last cluster there are four regional airports: AHO, AOI, GOA and PSR. The evolution of TFP and VFP are shown in figures 11 and 12 respectively.

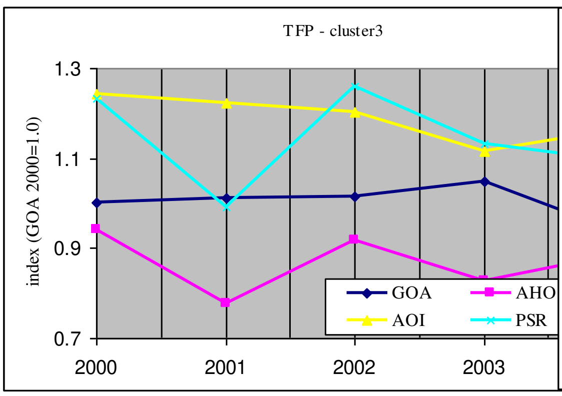

Figure 11. Cluster 1. TFP evolution.

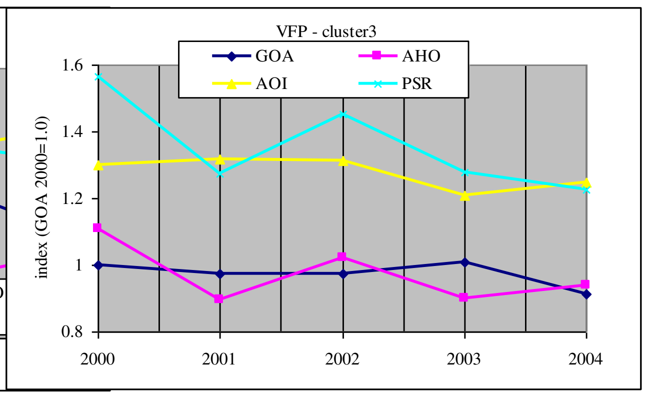

Figure 12. Cluster 1. VFP evolution.

[7] Catania terminal's position in terms of passengers traffic is the 4^{th} , after Rome, Milan and Venice.

The evolution of the two efficiency measures indicate the existence of a declining pattern. It is surprising the poor performance of Genova which is one of the Italian airports holding a complete concession agreement since 1954. One of the possible motivations that can be advocated for is the airport infrastructure inadequacy.

6.2. Residual TFP and VFP evolutions

Since both TFP and VFP can be influenced by a variety of factors, the next step in the analysis has been to eliminate sources of productivity difference that make meaningful comparison problematic. Following the literature and the empirical evidence stemming from the principal component analysis a set of variables has been considered in order to remove from the efficiency measures factors that are beyond the managerial control. The variable employed are: work load unit (*wlu*), airport size (*as*), non aeronautical share of total revenue (*nastr*), the ratio between the airport size and the work load unit (*as/wlu*), the ratio between national and international traffic(*nat/int*) and the level of airport coordination (*ac*) and the factors coordinates *(F1 and F2)*. For each cluster, before computing the regression, the correlation analysis among the explanatory variables has been carried out in order to reduce the multicollinaearity problem. In the regression analysis all the explicative variables are normalized on the base year and airport chosen for the computation of the TFP and VFP.

Cluster 1.

The residual Total Factor Productivity (RTFP) and the residual Variable Factor Productivity (RVFP) are computed by regressing TFP and VFP on the following variables: *wlu* and *nastr*. The regression models are shown in table 12.

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.

Table 12. TFP and VFP regression analysis.

The analysis of table 12 highlights the importance of the non aeronautical share of total revenue (*nastr*) in determining the airport efficiency of the two Italian airport systems. Moreover, the positive coefficient of *wlu*, in both the regression analysis, indicates that an increase of airports outputs will increase their efficiency. The RTFP and the VRFP evolutions are showed in figures 13 and 14.

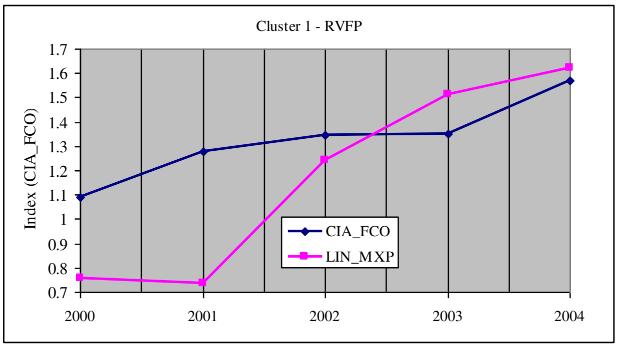

Figure 13. Cluster 1. TFP evolution.

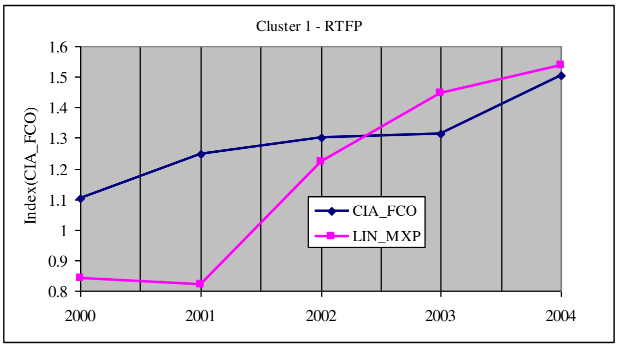

Figure 14. Cluster 1. VFP evolution.

How it was attended there are no changes in the raking between the two airports. Moreover the two figures confirm the presence of a convergence process between the two airport systems. In other terms, once a dimensional factor *(wlu)* and a variable measuring non aviation activity *(nastr)* have been taken into account the evolution of the two productivity measure do not change. Therefore the above result seems to confirm the positive effect on the operating efficiency caused by the competition between the two airport systems.

Cluster 2.

For this cluster the regression analysis has been conducted by regressing TFP and VFP on the following variables: *ac, F1, naz/int* and *wlu*. (see table 13)

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.

Table 13. TFP and VFP regression analysis.

The regression results confirm the difficulties in comparing the operating efficiency of airports characterised by different investment cycles. In fact whenever the capital measure is included in the analysis, that is TFP index, the regression suggests that an increase of efficiency should be obtained by expanding the output levels. This scenario is completed reverse when the variable is carried out, that is the VFP index. In fact it appears non statistically significant while the coefficient of variable *F1* suggests that airports exerting an high degree of capacity utilisation have a negative impact on VFP evolution. The coefficient of the variable measuring the impact of the coordination activity on the airport slot assignments, *ac*, is positive and statistically significant in both the regressions. This result could be surprising but it should be connected to the fact that the airports fully coordinated should be able trough the ASSOCLERANCE to attract more demand than the airports outside the association. Finally, the positive and significant coefficient of the variable measuring *naz/int* indicates that the operating efficiency is positively related the national traffic. The positive impact of the national traffic as opposite to the international one should be explained by several factors. First, the evolution of the national traffic, characterized by moderate seasonal patterns, could allow a better capacity utilisation. Second, the smaller average size of aircraft using by the airline company for the national flights should be suitable to the airport characteristics. Third the absence of an adequate commercial area could reduce one of the revenue sources which compensate the higher cost connected to international flights services.

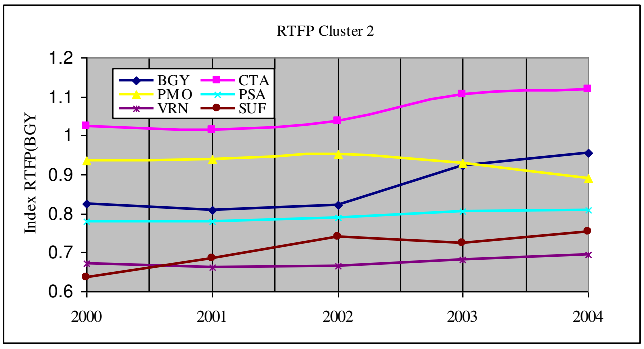

Figure 15. Cluster 1. TFP evolution.

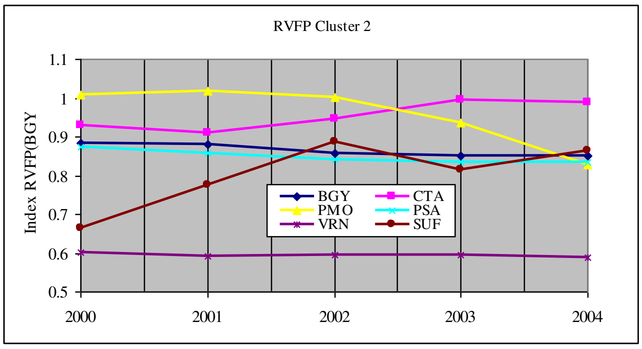

Figure 16. Cluster 1. VFP evolution

Now, when the variables employed in the regression analysis are taken into account there are some significant changes in the relative productivities between airports (figures 15 and 16). Looking at the RVFP evolution it appears a convergence process between four airports: PMO, BGY, SUF and PSA. In particular, on output adjusted VFP index PSA has reduced its distance from BGY. This is attributable to the fact that the residual measure has eliminated the effect of the coordination activity of BGY with the airport system of LIN_MPX. CTA, the only airport in the cluster holding a private-public ownership with a private majority, confirms its operating efficiency.

Cluster 3.

For the last cluster the variables employed in the regression analysis are: *as/wlu* and *nars*.

The variable *as/wlu*, positive and statistically significant, suggests that these airports should expand their capacity to increase their operative efficiency. Moreover, another source of efficiency improvement is represented by the rise of revenues coming from non aeronautical activities. The computation of RTFP and RVFP does not change the overall ranking (see figures 17 and 18) but it reduces the difference in the performances.

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)

Table 14. TFP and VFP regression analysis.

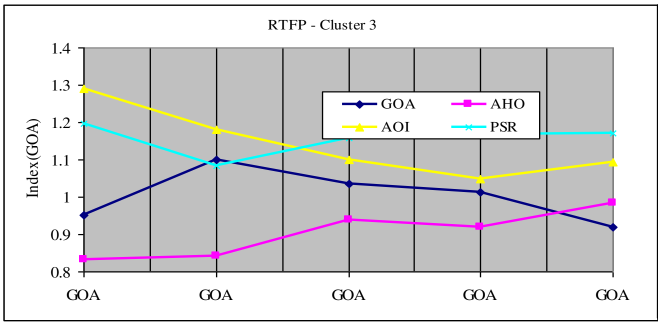

Figure 17. Cluster 1. TFP evolution.

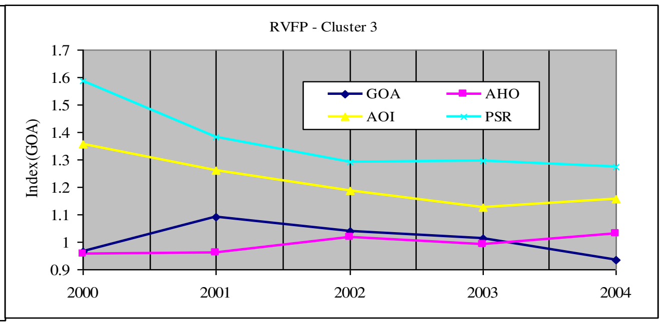

Figure 18. Cluster 1. VFP evolution

7. CONCLUDING REMARKS

In this paper the efficiency of 14 Italian airports has been estimated within the period 2000 to 2004. The set of variables which have been employed in the analysis concern both financial and physical aspects of airport operations. The analysis of the market determinants of the industry has highlighted how the 14 airports can not be considered as whole. In particular, the paper shows how the sources of heterogeneity stem both from structural and institutional factors. The structural factors that mainly affect the Italian airports are the hub and spoke structure adopted by the Italian national flag (Alitalia), the existence of seasonality in the airport traffic due to tourism and the traffic composition. As far as the institutional environmental is concerned the paper shows the presence of different concession agreements which have a great impact on the operations managed by the airport management companies. All these factors make the comparison of the operational difficult. Thus in order to solve such a problem the factorial and the cluster analysis have been employed. The cluster algorithm has individuated three airports groups. The first one is composed by the two Italian competing airport systems: Milan (Linate and Malpensa) and Rome (Ciampino and Fiumicino). In the second cluster there are six regional airports characterized by a steady growth in traffic and by capacity shortage. The third cluster is composed by small regional airports. The analysis of the operating efficiency has been obtained trough the computation of the Total Factor Productivity index (TFP) and of the Variable Productivity Index (VFP). The main empirical evidences are:

- the role played by the airport, hub or spoke, in the airports system and the governance form have positive impact on the airport operating efficiency;

- the increase of the operating efficiency of two Italian airport systems. Is this the competition effect?

- the regional airports seem suffer of capacity constraints.

The analysis of the residual Total Factor Productivity and of the residual Variable Factor Productivity shows a convergence process among the operational efficiencies of the airports included in cluster 1 and 2 respectively. For the third cluster the difference still persists suggesting the existence of others factors, including the management quality, which may affects the performances of these airports. Therefore paper shows, even if the analysis concern only the Italian airports, the difficulties in comparing airports which are characterized by different investments cycles. At the same time it shows how some consolidate techniques may be employed in reducing dissimilarity to improve efficiency measures. Finally, the application of the two multivariate techniques has allowed to eliminate the hetereschedasticity problems in regressing TFP and VFP on the set of variables which measure factors that are beyond the managerial control.

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APPENDIX

Table a1. IATA CODE

Airport	IATA code
Alghero	AHO
Ancona	AOI
Bergamo	BGY
Catania	CTA
Genova	GOA
Lamezia	SUF
Milan Linate	LIN
Milan Malpensa	MXP
Palermo	PMO
Pescara	PSR
Pisa	PSA
Rome Ciampino	CIA
Rome Fiumicino	FCO
Verona	VRN

Table a2. Correlation matrix

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ANALYSE EN COMPOSANTES PRINCIPALES
STATISTIQUES SOMMAIRES DES VARIABLES CONTINUES
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| NUM . IDEN - LIBELLE
|   1 . V1   - national passengers
|   2 . V2   - international passen
|   3 . V3   - wlu
|   4 . V4   - naz\int
|   6 . V6   - deprecian cost/wlu
|   8 . V8   - au
|   9 . V9   - total asset turn.
|  11 . V11  - total  revenues\wlu
|  13 . V13  - nastr
|  15 . V15  - revenue\expenditure
|  16 . V16  - roa
|  17 . V17  - roce
|  18 . V18  - operating margin
|  19 . V19  - ebitda
|  20 . V20  - ros
|  21 . V21  - roe
|  22 . V22  - debt ratio
|  23 . V23  - debt\equity ratio
|  24 . V24  - financial leverage
|  25 . V25  - total revenues\equit
|  29 . BG   - wlu/person
|  30 . BH   - labour cost\total co
|  32 . BJ   - wlu/movement
|---------------------------------------
|   5 . V5   - tcw
|   7 . V7   - tcw
|  10 . V10  - fat
|  12 . V12  - arpw
|  14 . V14  - crp
|  31 . BI   - as
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MATRICE DES CORRELATIONS

	V1	V2	V3	V4	V6	V8	V9	V11	V13	V15	V16	V17	V18	V19	V20	V21
V1	1.00															
V2	0.79	1.00														
V3	0.84	0.99	1.00													
V4	0.21	-0.34	-0.27	1.00												
V6	0.23	0.54	0.51	-0.73	1.00											
V8	0.11	-0.39	-0.30	0.81	-0.70	1.00										
V9	-0.06	-0.47	-0.42	0.41	-0.31	0.56	1.00									
V11	-0.14	0.10	0.06	-0.57	0.56	-0.73	0.08	1.00								
V13	0.13	0.20	0.18	-0.29	0.38	-0.58	0.02	0.78	1.00							
V15	0.69	0.78	0.78	-0.24	0.48	-0.08	-0.07	0.00	-0.14	1.00						
V16	0.30	0.26	0.27	0.01	0.09	0.27	0.09	-0.31	-0.59	0.65	1.00					
V17	0.60	0.53	0.56	-0.07	0.35	0.18	0.26	-0.09	-0.27	0.91	0.72	1.00				
V18	0.64	0.69	0.70	-0.22	0.46	-0.03	0.04	0.03	-0.16	0.99	0.68	0.94	1.00			
V19	0.61	0.73	0.73	-0.34	0.62	-0.14	-0.13	0.01	-0.16	0.97	0.64	0.89	0.96	1.00		
V20	0.35	0.34	0.35	-0.04	0.16	0.19	0.00	-0.26	-0.53	0.70	0.98	0.71	0.72	0.69	1.00	
V21	0.32	0.28	0.30	0.06	0.05	0.26	0.00	-0.34	-0.58	0.58	0.97	0.61	0.59	0.56	0.97	1.00
V22	0.28	0.43	0.43	-0.19	0.38	-0.41	-0.05	0.63	0.71	0.21	-0.23	0.07	0.18	0.15	-0.18	-0.23
V23	-0.04	0.09	0.08	-0.20	0.33	-0.51	-0.08	0.76	0.76	-0.20	-0.45	-0.30	-0.21	-0.21	-0.43	-0.43
V24	-0.10	0.03	0.02	-0.15	0.23	-0.49	-0.21	0.62	0.70	-0.36	-0.54	-0.46	-0.39	-0.36	-0.53	-0.49
V25	-0.35	-0.38	-0.39	0.04	-0.05	-0.21	0.26	0.66	0.63	-0.51	-0.50	-0.48	-0.47	-0.54	-0.51	-0.49
BG	0.52	0.36	0.43	0.18	0.09	0.36	-0.19	-0.54	-0.19	0.25	0.03	0.22	0.20	0.33	0.05	0.04
BH	0.13	-0.02	0.00	0.49	-0.57	0.60	0.31	-0.51	-0.59	0.34	0.61	0.44	0.37	0.19	0.58	0.59
BJ	0.60	0.47	0.52	0.37	-0.08	0.44	-0.20	-0.67	-0.63	0.61	0.57	0.60	0.56	0.57	0.56	0.58
	V1	V2	V3	V4	V6	V8	V9	V11	V13	V15	V16	V17	V18	V19	V20	V21

	V23	V24	V25	BG	BH	BJ
V23	1.00					
V24	0.96	1.00				
V25	0.86	0.83	1.00			
BG	-0.27	-0.21	-0.46	1.00		
BH	-0.48	-0.54	-0.32	-0.13	1.00	
BJ	-0.43	-0.42	-0.63	0.53	0.54	1.00