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EVALUATING AIRPORT EFFICIENCY USING DATA ENVELOPMENT ANALYSIS¹

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Abstract

Performance measurements have become an issue of the utmost importance in the airport business, as airports become more competitive and face the challenging market environment. Thus, the analysis of airport efficiency might help to increase competitiveness. The paper aims to assess the efficiency of Croatian airports over the five-year period 2004-2008 using Data Envelopment Analysis (DEA). DEA has been proven as a valuable performance evaluation methodology when homogeneous decision-making units (DMUs) have multiple inputs and outputs and operate in similar conditions. Initially, DEA has been deployed to analyse the efficiency of Croatian airports in 2008. The analysis has revealed that only Split Airport and Dubrovnik Airport are relative efficient performers. DEA provides estimates of the potential improvement that can be made by inefficient airports. The analysis has then been extended by utilising window analysis, which is useful for detecting efficiency trends of DMUs over time. It has shown significant disparities in efficiencies among the airports over the period examined.

Key Words: Data Envelopment Analysis, efficiency, competitiveness, Croatian airports

Topic Groups: Industry, area or region specific studies, International business

INTRODUCTION

The efficiency of an airport is one of the most significant determinants of the success and progress in the airport business. With the processes of deregulation and liberalization within the air transport industry, airports began to contend with each other and to improve their

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efficiency in order to have a competitive edge. In that sense, it is essential to realize which airports are performing well and which are underperforming, as well as to indicate relative inefficiencies in order to improve their performance.

Data Envelopment Analysis (DEA) is a non-parametric multiple input-output methodology that assesses the relative efficiency of decision-making units (DMUs) using a linear programming based model. In that context, airports operate in similar conditions and can be regarded as decision-making entities and uniform decision-making units, with regard to both input and output components.

The main objective of the paper is to apply Data Envelopment Analysis to analyse the efficiency and overall performance of Croatian airports. The DEA model is also very useful in indicating relative inefficiencies in order to improve the performance. The paper attempts to investigate the efficiency of Croatian airports during the year 2008 and the period 2004-2008.

The paper is structured as follows: Section 2 provides the results of previous studies on airport efficiency applying Data Envelopment Analysis. This is followed by introducing the DEA method and describing its main characteristics. Then, in Section 4, data and methodology are presented. The following section presents the results of the DEA analysis and its discussion. Finally, certain conclusions emerging from the previous sections are outlined and some proposals for the improvement of future research are indicated.

LITERATURE REVIEW

Assessing the efficiency of airports by applying Data Envelopment Analysis has been the subject of much research in the recent past (Martin and Roman, 2001, 2006, 2008; Abbott and Wu, 2002; Yoshida and Fujimoto, 2004; Yu, 2004; Malighetti et al., 2007; Barros and Dieke, 2007, 2008; Fung et al., 2008; Tapiador et al., 2008; Chi-Lok and Zhang, 2009).

Previous research on the assessment of airport efficiency through the use of DEA methods reveals the following results:

- significant differences in efficiencies among airports depending on their geographical location (Sarkis, 2000; Yu, 2004; Yoshida and Fujimoto, 2004; Lin and Hong, 2006; Tapiador et al., 2008; Fung et al., 2008)
- airports with more competition are more efficient than their counterparts (Yu, 2004; Chi-Lok and Zhang, 2009)
- partially and fully privatised airports are more efficient than publicly owned ones (Vogel, 2005)
- fully private airports tend to have higher efficiency scores than partially private airport authorities (Barros and Dieke, 2007)
- airports with higher WLU (work load unit) tend to be more efficient than those with lower WLU (Barros and Dieke, 2007), which can be explained by the economies of scale (Graham, 2005)
- efficiency is related to airports` size i.e. large airports (with more than 5 million passengers) are more efficient than domestic and regional ones (Malighetti et al., 2007; Barros and Dieke, 2007; Yoshida and Fujimoto, 2004; Martin and Roman, 2008)
- the status of public-owned management company has a positive impact on the efficiency (Curi et al., 2010)

- the changes in managerial style influence airport performance (Pacheco and Fernandes, 2003; Pacheco et al., 2006)

Numerous studies evidently confirm that Data Envelopment Analysis has been a widely utilized method in the literature on airport efficiency and productivity.

DATA ENVELOPMENT ANALYSIS

In order to measure the efficiency of the airports, we apply the widely utilised and useful methodology - Data Envelopment Analysis. It is a methodology which enables comparative efficiency analysis of the decision-making units (DMUs). It uses a specific set of resource inputs in order to produce a specific set of outputs without knowing the form specification of the relation between inputs and outputs. The DEA is a nonparametric efficiency measurement that uses linear programming methods to construct a piecewise linear surface or frontier over the data. Through the reference to this frontier, we can determine the position of inefficient units and identify the sources and the amounts of inefficiency.

Graham (2005) notes that the key advantage of DEA is that the weights for the inputs and outputs are not pre-determined but instead are the results of the linear programming procedure. She also outlines that DEA is often a more attractive technique than other methods because it has less demanding data requirements and, therefore, has been used more extensively to measure airport performance.

Let us suppose there are n DMUs: $DMU_1, DMU_2, \dots, DMU_n$. Some common input and output items for each of these $j = 1, \dots, n$ DMUs are selected as follows (Cooper et al., 2006):

1. Numerical data are available for each input and output, with the data assumed to be positive for all DMUs;
2. The items (inputs, outputs and choice of DMUs) should reflect an analyst's or a manager's interest in the components that will enter into the relative efficiency evaluations of the DMUs;
3. In principle, smaller input amounts are preferable and larger output amounts are preferable so the efficiency scores should reflect these principles;
4. The measurement units of the different inputs and outputs need not be congruent.

The determination of the efficiency score of the i th airport in a sample of N airports in the constant returns to scale will be based on one of the fundamental models of DEA: CCR model. Efficiency is defined as the ratio of weighted sum of outputs to weighted sum of inputs. The fundamental idea of the model is to determine the weight that maximises the goal function: ratio of virtual inputs and outputs, after their establishment through the relevant weights. More precisely: let us suppose to have available data on some n decision-making units that utilise the m of the same inputs and realise the s of the same outputs. In order to determine the values for the inputs' "weights" (v_i) ($i = 1, \dots, m$) and the outputs' "weights" (u_r) ($r = 1, \dots, s$) which represent the variables, we are solving the following problem of the fraction programming (Cooper et al., 2000):

$$\max \quad \theta = \frac{u_1 y_{10} + u_2 y_{20} + \dots + u_s y_{s0}}{v_1 x_{10} + v_2 x_{20} + \dots + v_m x_{m0}}$$

s.t.

$$\frac{u_1 y_{1j} + \dots + u_s y_{sj}}{v_1 x_{1j} + \dots + v_m x_{mj}} \leq 1 \quad (j = 1, \dots, n)$$

$$v_1, v_2, \dots, v_m \geq 0$$

$$u_1, u_2, \dots, u_s \geq 0$$

The variables (u_r) ($r = 1, \dots, s$) and (v_i) ($i = 1, \dots, m$) are determined through the CCR model for each DMU, they are not previously given. Consequently, the data on inputs and outputs enters the goal function. The restrictions mean that the ratio of "virtual outputs" and "virtual inputs" cannot cross the value of 1, for each DMU. If the optimal value is $\theta^* = \max \theta = 1$, the efficiency for the relevant DMU has been reached.

DATA AND METHODOLOGY

There are seven airports handling international air traffic in the Republic of Croatia – Zagreb, Split, Dubrovnik, Zadar, Rijeka, Pula and Osijek. A 55% stake in each is owned by the state, with the remaining 45% divided between different levels of regional and local authorities. In terms of total passenger volume, Croatia airports recorded 4,897.975 passengers in 2009 ([http:// www.mmpi.hr](http://www.mmpi.hr)). The airports of Zagreb, Split and Dubrovnik amount to approximately 85% of the total passenger traffic in Croatia.

The goal of the analysis is to make the cross-airports comparison of performance. For this purpose, CCR input-oriented model (constant returns to scale) and the DEA-SolverPro6.0 software program have been utilised. Adequate choice of inputs and outputs represents an important step in the DEA utilisation. Two variables make up the inputs: operating costs and the number of employees. The output is measured by one variable: total revenues. All input and output data were taken from the annual reports of the airports, which provide information on the airports` physical and financial parameters. The combination of input and output variables meets the DEA convention that the minimum number of DMU observations should be greater than two times the number of inputs plus outputs.

As Mantri (2008) notes, conventional DEA is static, i.e. the analysis does not consider the time frame to which the input consumption and output production refers. However, multi-period efficiency measurement is possible through window analysis. Initiated by Charnes et al. (1985), window analysis is a time-dependent version of DEA with various applications. The input/output data of the DMUs for a number of consecutive periods (i.e. a window) are used to assess the efficiency of each DMU in each period.

After selecting input and output variables in the first stage, the efficiency scores of Croatian airports in 2008 are analysed. This is followed by identifying sources and amounts of relative inefficiency. In the second stage we proceed with window analysis, which is applied to provide trend information on the relative efficiency scores of Croatian airports over the five-year period 2004-2008.

DEA RESULTS AND DISCUSSION

The correlation analysis for seven Croatian airports shows that there is a strong relationship between inputs and output: between operating costs and revenues 0.96453257, and between the number of employees and revenues 0.85041342 (Table 1).

Table 1: Correlation matrix

	OPER. COSTS	EMPLOYEES	REVENUES
OPER. COSTS	1	0.937752	0.96453257
EMPLOYEES	0.9377518	1	0.85041342
REVENUES	0.9645326	0.850413	1

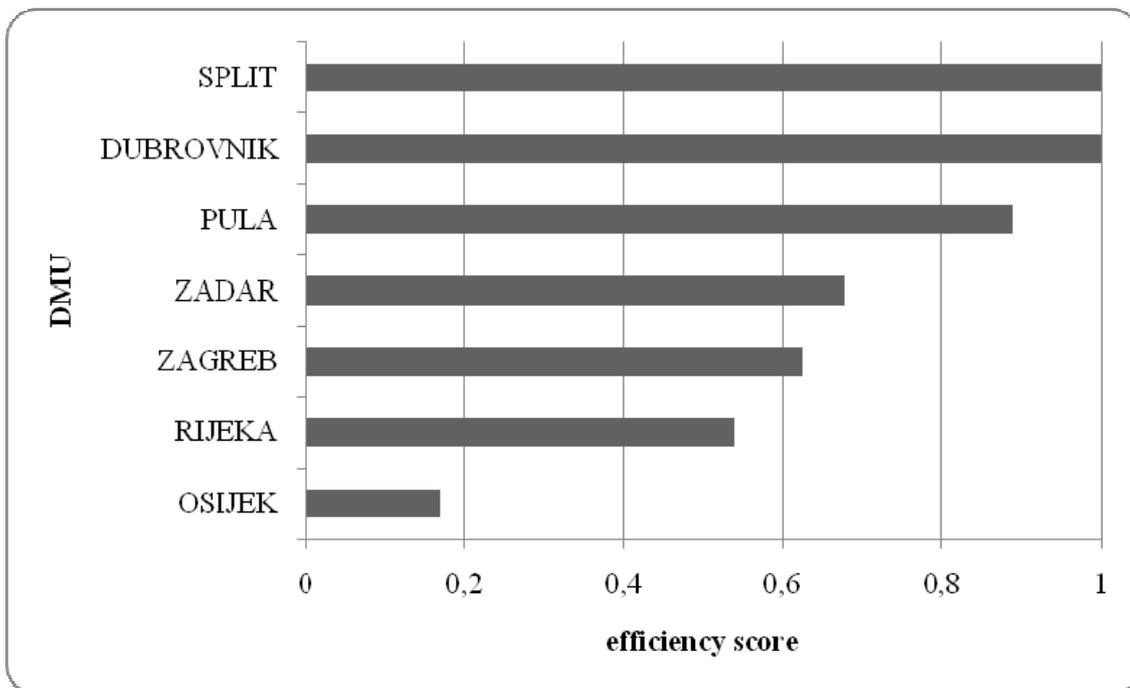
The results of relative efficiency for seven Croatian airports are presented in Table 2. The position in the ranking based on these scores is displayed in the third column.

Table 2: Efficiency scores, 2008

DMU	Score	Rank
DUBROVNIK	1	1
OSIJEK	0.168968	7
PULA	0.887644	3
RIJEKA	0.539099	6
SPLIT	1	1
ZADAR	0.677358	4
ZAGREB	0.624301	5

The efficiency indices diverge from 0.168968 to 1. These efficiency scores show that only Dubrovnik Airport and Split Airport are relative efficient airports having a max-efficiency value of 1.0.

Figure 1: Relative efficiency scores, 2008



That would mean that they could not increase the outputs without increasing the inputs, nor reduce the inputs without reducing the outputs. Osijek's efficiency is 0.168968, i.e. Osijek Airport achieved only approximately 16% of Dubrovnik's and Split's efficiency. Pula Airport is

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approximately 89% efficient compared to Dubrovnik and Split while Rijeka achieved 54% efficiency. Zadar achieved 68% efficiency and Zagreb approximately 62% of Dubrovnik's and Split's efficiency. Relative efficiency scores are also shown in Figure 1.

Table 3 contains the improvements required in order to make inefficient airports efficient. As seen in Table 3, results suggest that all inefficient airports could improve their efficiency on both input variables, i.e. these airports might reduce some of the inputs. Having this information, airport managers should concentrate their efforts in enhancing the performance.

Table 3: Projections values

No.	DMU I/O	Score Data	Projection	Difference	%
1	DUBROVNIK	1			
	OPER. COSTS	40012470	40012470	0	0.00%
	EMPLOYEES	350	350	0	0.00%
	REVENUES	152301507	152301507	0	0.00%
2	OSIJEK	0.16896829			
	OPER. COSTS	4320385	730008.075	-3590376.9	-83.10%
	EMPLOYEES	42	6.38557995	-35.61442	-84.80%
	REVENUES	2778667	2778667	0	0.00%
3	PULA	0.88764376			
	OPER. COSTS	17624641	15644402.6	-1980238.4	-11.24%
	EMPLOYEES	171	136.845861	-34.154139	-19.97%
	REVENUES	59548088	59548088	0	0.00%
4	RIJEKA	0.53909907			
	OPER. COSTS	4369012	2355330.31	-2013681.7	-46.09%
	EMPLOYEES	76	20.6027173	-55.397283	-72.89%
	REVENUES	8965214	8965214	0	0.00%
5	SPLIT	1			
	OPER. COSTS	62267000	62267000	0	0.00%
	EMPLOYEES	380	380	0	0.00%
	REVENUES	184865000	184865000	0	0.00%
6	ZADAR	0.6773584			
	OPER. COSTS	7886054	5341684.93	-2544369.1	-32.26%
	EMPLOYEES	99	46.7251765	-52.274823	-52.80%
	REVENUES	20332328	20332328	0	0.00%
7	ZAGREB	0.62430105			
	OPER. COSTS	78889943	49251074.5	-29638868	-37.57%
	EMPLOYEES	875	430.812596	-444.1874	-50.76%
	REVENUES	187466879	187466879	0	0.00%

Since the model is input-orientated, output is considered as a constant. That is why projections suggest decreasing the inputs for all inefficient airports in order to become relative efficient. The total number of employees should decrease as follows: Osijek Airport by about 85%, Pula Airport 20%, Rijeka Airport 73%, Zadar Airport 53% and Zagreb 51%. With regard to expenditures, Osijek Airport should decrease expenditures by about 83%, Zadar Airport should decrease expenditures by 32%, Rijeka Airport by 46%, Pula Airport by

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11%, while Zagreb Airport should decrease expenditures by 37%. These percentages suggest significant surplus of both employees and expenditures for all inefficient airports.

One of the advantages of DEA lies in its ability to identify the area of excess. In that context, the basic DEA efficiency results are extended by decomposing the efficiency scores. This decomposition indicates the sources of inefficiency. It is interesting to examine an excess in an input (or a shortage in an output) from the optimal solution of the model. DEA is able to identify the exact amount of excess or slack. In that way, it helps allocate resources between airports more efficiently.

Table 4: Decomposition of efficiency score

DMU	Score	Excess OPER.COSTS S-(1)	Excess EMPLOYEES S-(2)	Shortage REVENUES S+(1)
DUBROVNIK	1	0	0	0
OSIJEK	0.168968	0	0.711088	0
PULA	0.887644	0	14.94122	0
RIJEKA	0.539099	0	20.36881	0
SPLIT	1	0	0	0
ZADAR	0.677358	0	20.33331	0
ZAGREB	0.624301	0	115.4508	0

The Table 4 decomposes inefficiency into each input/output factor. It indicates that the excess of employees dominates the other input in inefficiency. These pieces of information further increase the usefulness of DEA as a means of assessing airports' performances.

Until now we have dealt with DEA under static conditions. When the time is not considered, the efficiency results can be biased. In order to deal with this, further analysis is extended by adopting DEA window analysis approach. The basic idea of window analysis is to regard each DMU as if it were different DMU in each of the reporting dates: a DMU is compared to itself over time. It is useful for detecting efficiency trends of DMU over time. The efficiency of Croatian airports for the period 2004-2008 is displayed in Table 5 and the efficiency of these airports is analysed over time. As it can be noted in the last row in Table 5, results indicate that the overall average efficiencies of Croatian airports haven't shown considerable fluctuations over the five-year period analysed.

Table 6 contains the averages through a window. The first window incorporates years 2004, 2005 and 2006. Generally, when a new period is introduced into a window, the earliest period is dropped. In the next window the year 2004 will be dropped and year the 2007 will be added to the window. The analysis is over when the window analyses years 2006, 2007 and 2008.

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Table 5: DEA-CCR window analysis for airport efficiency

	2004	2005	2006	2007	2008	Average	C-Average
DBV	0.947094	1	1			0.982365	
		1	1	0.938243		0.979414	
			1	0.88464	1	0.961547	0.974442
OSI	0.182574	0.390865	0.189535			0.254325	
		0.390865	0.189535	0.131413		0.237271	
			0.189535	0.131413	0.160851	0.1606	0.217398
PUL	0.732631	0.863112	0.910461			0.835401	
		0.863112	0.910461	0.861166		0.878246	
			0.910461	0.843008	0.845797	0.866422	0.860023
RIJ	0.449493	0.636746	0.416383			0.500874	
		0.636746	0.416383	0.467134		0.506754	
			0.416383	0.467134	0.451373	0.444963	0.484197
SPL	0.717182	0.84154	1			0.852907	
		0.806261	0.941383	1		0.915882	
			0.876742	0.931606	1	0.936116	0.901635
ZAD	0.409132	0.486762	0.425828			0.440574	
		0.486762	0.425828	0.496994		0.469861	
			0.425828	0.5001	0.567134	0.497687	0.469374
ZAG	0.741541	0.7237	0.485737			0.650326	
		0.720313	0.484632	0.527461		0.577469	
			0.486466	0.524822	0.556698	0.522662	0.583485
Average	0.597092	0.703342	0.623885	0.621795	0.654551		

Table 6: Average through window

	2004-2005-2006	2005-2006-2007	2006-2007-2008
DUBROVNIK	0.982365	0.979414	0.961547
OSIJEK	0.254325	0.237271	0.1606
PULA	0.835401	0.878246	0.866422
RIJEKA	0.500874	0.506754	0.444963
SPLIT	0.852907	0.915882	0.936116
ZADAR	0.440574	0.469861	0.497687
ZAGREB	0.650326	0.577469	0.522662

Figure 2 shows relative efficiency trend for all analysed airports. It can be observed that Dubrovnik Airport achieved the best average scores for all three windows.

Consequently, the final average score for Dubrovnik Airport is the best one equals 0.974442 (column C-Average). Split Airport is estimated as the second with score 0.901635 and so on.

Figure 2: Relative efficiency variation through window

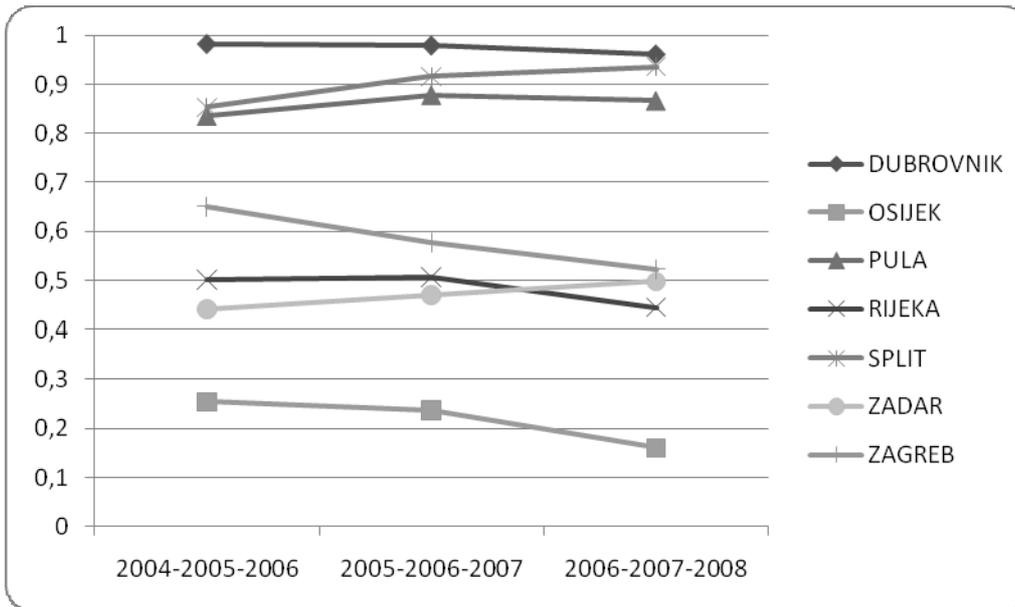


Figure 3: Relative efficiency variation by term

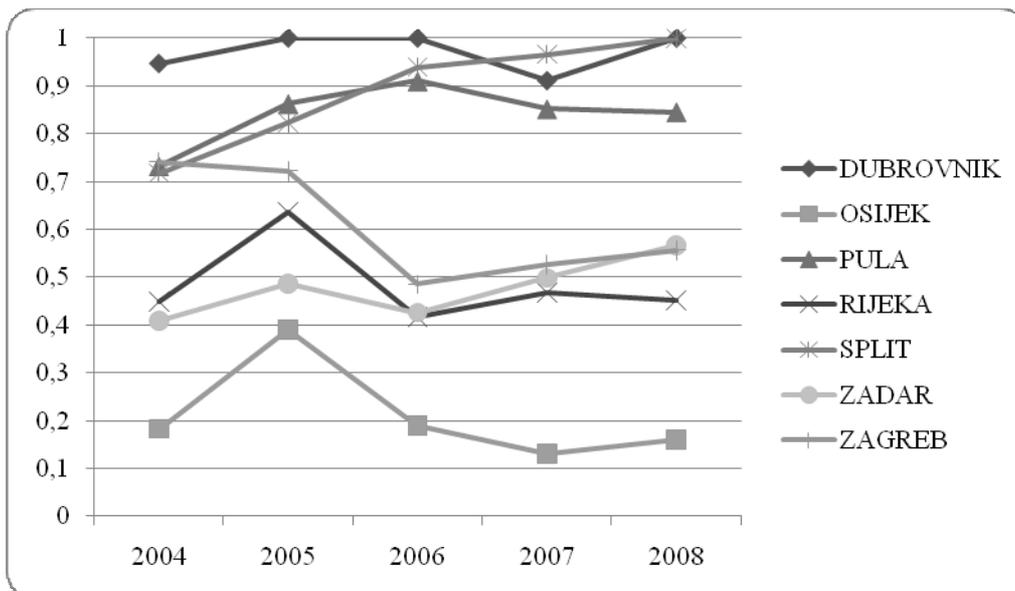


Figure 3 presents relative efficiency variation by term. When considering each year of the period 2004-2008, the results indicate no regular trend in average airport efficiency variation. Furthermore, a significant difference in relative efficiency among Croatian airports is obvious. Figure 3 shows that Dubrovnik Airport, as well as Split Airport, were the most efficient on average, followed by Pula Airport and Zadar Airport which reveal relatively steady efficiency trends. In contrast, Zagreb Airport and Rijeka Airport recorded some considerable drops in efficiency scores in the last 3 consecutive years (2006-2008), whereas Osijek Airport was the least efficient and, at the same time, it is the airport with fewest passengers per year in Croatia.

CONCLUSIONS AND IMPLICATIONS

This paper uses the well established Data Envelopment Analysis method to compare the relative efficiencies of Croatian airports. The method is very useful since it also provides

estimates of the potential improvement that can be made by inefficient DMUs. In this case, an input-oriented CCR model has been utilised to assess the overall efficiency of seven Croatian airports in the year 2008 and over the five-year period 2004-2008.

This paper provides new empirical evidence on the trends in efficiency of Croatian airports and, consequently, it contributes to the existing airport efficiency literature by presenting an assessment of the efficiency of Croatian airports by applying the Data Envelopment Analysis methodology. To the best extent of authors' knowledge, this is the first time that this data set, i.e. input and output variables, have been applied to compute the efficiency of the airports in Croatia through the use of DEA methods.

Input data include operating costs and the number of employees while output data is comprised of total revenues. In that sense, the correlation analysis shows the existence of strong correlation between inputs and output. The analysis has revealed that only Split Airport and Dubrovnik Airport are relative efficient performers in comparison to the other airports. Projection values also identified the amounts of relative inefficiency and suggested improvements for all inefficient airports. In that context, the results revealed that all inefficient airports could improve their efficiency by reducing some of the inputs. Furthermore, by decomposing the efficiency scores DEA identifies the area of excess and, in that way, helps allocate resources more efficiently between airports. The decomposition of efficiency scores indicates that the excess of employees dominates the other input in inefficiency. In order to avoid the use of a single year to calculate airports' efficiency, the analysis has been extended by utilising window analysis, which is useful for detecting efficiency trends of DMUs over time. The length of the window is chosen as three, containing periods 2004-2005-2006, 2005-2006-2007 and 2006-2007-2008. The analysis has shown significant disparities in efficiencies among the airports over the period examined. However, the overall average efficiencies of Croatian airports haven't indicated considerable fluctuations over the five-year period analysed.

It is worth mentioning some potential limitations of our analysis. It primarily refers to model limitations, namely the number of input and output variables. Bearing in mind that there are seven airports handling international air traffic in Croatia, the number of input and output variables was limited. Given the number of DMUs has to be at least twice the sum of the input and output variables, only two inputs and one output were considered when estimating the efficiency scores of Croatian airports. In that respect, the influence of other variables on the performance of Croatian airports is missing and further research is needed.

The research presented here can be extended and improved in at least several ways. First, by continuing to measure airport efficiency, it can be investigated how it has evolved over time. There are several areas worthy of consideration for further research. The input and output variables are not exhaustive. Other inputs (e.g. terminal area, runway area, number of check-in counters, number of gates, number of aircraft parking positions, number of baggage claims, etc.) and outputs (e.g. number of passengers, aircraft movements, amount of cargo handled, commercial revenues, aeronautical revenues, etc.) could be included into the model and analysed. Another interesting direction of research is to compare the efficiency of Croatian airports with airports in other countries, i.e. relatively similar markets, particularly with regard to size and ownership of airports. The analysis can identify and highlight similarities and differences between airport efficiency in Croatia and other countries. It would also allow the positioning of Croatian airports in a national and international context, i.e. ranking of Croatian airports in a wider context. The above mentioned issues should be considered for further research.

Based on the results of the analysis, there are some suggestions concerning airport managers. By comparing the performances of an airport with the results of the other airports certain pieces of information for self improvements can be gained. This information requires special attention as it can be important in order to enhance the overall airports` performance. In that sense, airport managers should evaluate and benchmark their performances with airports having similar characteristics. The results can also be interesting for airlines. Due to ever-increasing competition from low-cost airlines, they will increasingly focus on efficient airports and choose them for their operations. Furthermore, counties and municipalities could also be interested in performance evaluation of Croatian airports as efficient airports result in an increase in tourist flows and further development of their regions.

With regard to the methodology, the airports` performance in this paper was evaluated by the DEA model. However, other methods (e.g. stochastic frontier analysis, total factor productivity) should be applied as well in order to confirm the results and to provide further information on the subject.

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INTERNATIONAL BUSINESS STUDENTS' ATTITUDES OF ENTREPRENEURSHIP

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Abstract

The study examined attitudes of business students (n = 106) towards entrepreneurship in an international business management degree programme in Finland. The findings indicated that male students did not have more entrepreneurial features than female students, but they had more motivational factors and interest for entrepreneurship than female students. The barriers of entrepreneurship are lower for male students than the female students. The entrepreneurial features and characteristics are positively related to the interest for one's own enterprise and to the entrepreneurial motives. In addition, motivational factors are negatively correlated to the barriers of entrepreneurship. The findings illustrated that even if there was an entrepreneur in the core family or among acquaintances, it had no statistically significant influence on the entrepreneurial intention of the students. Further, to summarise the findings related to the stability of attitudes, it seems that they do not differ between the academic study groups or change during the study years, but remain the same.

Key words: attitudes, entrepreneurship, gender, intention, students

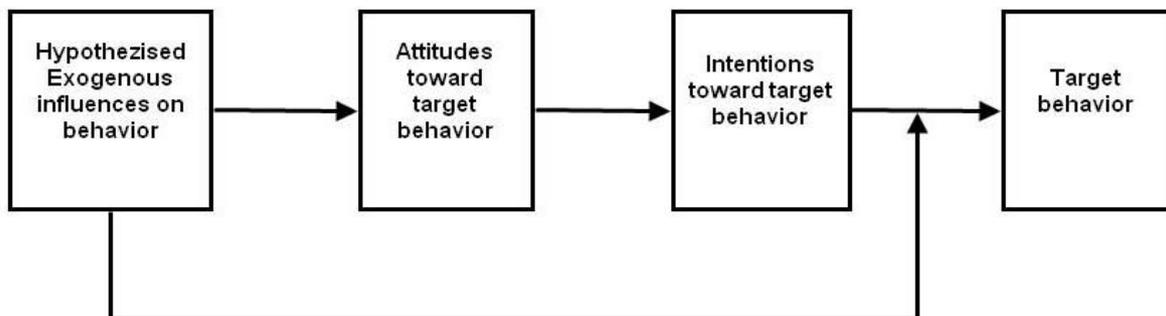
INTRODUCTION

Attitudes toward the behaviour, subjective norms, and perceptions of behavioural control have influence on one's own intentions. According to the theory of planned behaviour, people act in accordance with their intentions and perceptions of control over the behaviour. (Ajzen, 2001). For example, to start a business is intentional and can best be predicted by intentions. Starting a business can not be predicted by attitudes, beliefs, personalities or demographics. However, intentions are best predicted by certain attitudes. In other words, attitudes predict intentions which, in turn, predict behaviour, and further, only intentions directly affect behaviour, while attitudes affect intentions. (Ajzen 2001; Krueger & Carsrud, 1993). Figure 1 presents the basic intention-based process model.

In general, an attitude represents a summary evaluation of a psychological object. Further, one's own belief associates the object with a certain attribute, and the person's overall attitude toward an object is determined by the subjective values of the object's attributes in interaction with the strength of the associations. Only beliefs that are readily accessible in memory influence attitudes at any given moment (Ajzen, 2001). Thus, an attitude is a mentally prepared state for any known subject, and it is a subjective consciousness that is affected by the environment. The attitude toward entrepreneurship, in turn, is an individual's concept about entrepreneurship, assessment, and inclination towards entrepreneurial behaviour of self-employment. (Chen & Lai 2010, 3). All in all, attitudes are relevant for understanding and predicting people's social behaviour (Ajzen, 2001). This quantitative study aimed to find out the attitudes of business students towards entrepreneurship in a business

management programme in Finland. It is worth emphasising that the aim was not to examine their intention as a planned behaviour. Further, since the level of intention seems to be higher when the students have spent a long period of time in a foreign country (DeGeorge & Fayolle, 2008), the sample has been selected by including only international student groups in it. Further, the sample consisted of female and male students, and they represented different nationalities.

Figure 1: The basic intention-based process model (Krueger & Carsrud 1993, 317)



RESEARCH QUESTIONS

The main objective of the study was to find out the attitudes of international students towards entrepreneurship. Based on the objective of this study, the research questions were formulated according to the findings of the previous studies as follows:

Gender differences of entrepreneurial attitudes

Despite the increasing number of females who start their own businesses in the western countries, their number still lags behind that of male entrepreneurs (Ljunggren & Kolvereid 1996, 3; Verheul, van Stel & Thurik 2006, 151). The distinction between female and male entrepreneurship reflects the work-force in general. Traditional occupations for female entrepreneurs have been, for example, in hairdressing, and in the hotel and restaurant business. Nowadays female entrepreneurs act also in other fields, such as in training and consultancy. (Aaltio et al., 2008). In previous studies new female entrepreneurs have emphasized independence as a reason for starting up a new venture (Ljunggren & Kolvereid 1996; Carrier et al., 2008). Further, common reasons for women to start up a business are also the desire for self-fulfillment and the possibility of making profit. (Carrier et al., 2008).

According to the research findings of Verheul, van Stel & Thurik (1996) there is a positive effect of the life satisfaction on female entrepreneurship. They explained the fact that for women, it may be important that they feel confident about themselves and the environment before they decide to start a business.

According to several previous studies male students express higher interest for entrepreneurship and are more likely to start their own businesses. For example, in the findings of Urbano (2006) gender had a significant effect on the intention of starting up one's own company. Also the findings of Kundu and Rani (2008) demonstrated that gender and family background had significant effects on determining one's entrepreneurial attitude orientation in general. However, there are also a few studies which indicate that gender had no significant effect on intentions to start a business. In other words, female students are as

likely as male students to become entrepreneurs and set up their own businesses. (Shinnar et al., 2009).

Thus, based on these contradictory perspectives introduced above and in order to understand the gender differences in the selected context, the first research question was formulated as follows: **“How does gender influence the attitudes towards entrepreneurship?”**

Entrepreneurial characteristics, interest, motives and barriers

There are several studies indicating many positive characteristics related to entrepreneurship and entrepreneurial behaviour. For example, Henry et al. (2003) have summarized the main focus of the previous psychological studies related to entrepreneurial characteristics between 1961 – 1998 as follows: need for achievement, need for power, need for affiliation, risk-taking propensity, internal locus of control, initiative/drive/enthusiasm, confidence, need for autonomy and independence, innovativeness, decision-making, communication abilities, commitment/determination, leadership, judgement, tolerance of ambiguity and uncertainty, a grip on reality, and vision. The findings of Chen and Lai (2010) indicated that the students' attitude toward entrepreneurship was affected by environmental cognition and personal traits, which indirectly effects attitudes toward entrepreneurship. Nevertheless, the need for achievement, locus of control and creative thinking were the most important characteristics for entrepreneurship. Ristimäki (2004) summarises the features and characteristics of a person behaving entrepreneurially as follows: being self-confident, persistent, creative, independent, flexible, energetic, dynamic, optimistic, and having an ability to take risks, need for achievement, uncertainty-bearing attitude, and sense of responsibility. He continues that the diversity of the features is large and some of them are related to personality, while some of them are related to learning and growth. Also Gibb (2005) argues that many entrepreneurial features and characteristics can be developed, yet some of them can also be regarded as in-born characteristics.

Nowadays more and more young highly educated people with formal management skills establish their own enterprises. They might lack work experience and therefore many realities of business life, yet often they are full of enthusiasm and motivation which are required particularly in many new industries. In fact, the key characteristics of successful entrepreneurs are related to the way in which they approach their tasks. The characteristics base on their commitment, interest and motivation. (Wickham, 1998). Motivation arouses, directs and maintains human behavior toward attaining some goal. According to the findings of numerous studies entrepreneurs seem to have higher achievement motivation than non-entrepreneurs. (Henry et al., 2003). In the findings of Urbano's study (2006) the most significant motives to become an entrepreneur among university students were related to personal independency and creating something for your own.

Based on the references presented above, and in order to understand entrepreneurial characteristics, interest, motives and barriers in the selected context, the second research question was formulated as follows: **“How are Entrepreneurial characteristics and Interest for one's own enterprise as well as Entrepreneurial motives and Barriers of entrepreneurship related to each other?”**

Entrepreneurial intention

Entrepreneurial intention refers to the intention to start a new venture. The findings of Pihkala (2008) indicate that entrepreneurial intention of polytechnic (UAS) students seems to be constant during the studies. Further, although the studies of higher education increase

the awareness of entrepreneurship in general, they do not support and enhance the entrepreneurial intention. In fact, it seems that the conceptions of entrepreneurship became more negative during the studies, which does not support the entrepreneurial intention to set up one's own business. The variable of entrepreneurial intention for a study can be operationalized in different ways. For example, Urbano (2006) asked directly if a respondent had ever thought seriously of setting up or founding one's own company. He gave five-scale alternatives for answering (number 1 being "No, never" and number 5 being "Yes, I have a firm intention of setting up a company"). Further, Autio et al. (2001) used the statements in assessing the perceived likelihood of the individual to start a new firm, either on part-time or full-time basis, within one or five years from the time when the survey was carried out. The findings of Urbano (2006) indicated that if there were entrepreneurs among relatives, it had a significant effect on the intention of starting up one's own company. Also the findings of Degeorge & Fayolle (2008) support that the level of intention seems to be higher when there is an entrepreneur as a close relative, yet at the statistical level the relation was not significant in their results. To find out this relationship in the selected context, the third research question of the study was formulated as follows: **"How is the perceived entrepreneurial intention related to there being an entrepreneur in the core family or among acquaintances?"**

Stability of attitudes

Strong attitudes are expected to be relatively resistant to change. Thus, despite some recent contradictory findings, strong attitudes are said to be relatively stable over time, to be resistant to persuasion, and to predict manifest behaviour. Further, high personal relevance of information on which an attitude is based increases its strength. (Ajzen, 2001). According to the findings of Degeorge and Fayolle (2008) entrepreneurial intention level seems to be a stable variable over a long period time. In other words, the academic year of the programme does not have influence on the variable, which was also supported by the findings of Shinnar et al. (2009). In addition, based on previous studies, it seems that when attitudes change, the new attitude overrides but does not replace the old attitude. According to this model of dual attitudes, a person can simultaneously hold two different attitudes toward a given object in the same context. Then, one attitude is implicit or habitual and the other one is explicit. (Ajzen, 2001). For example, according to the findings of Leskinen (1999) the changes of students' conceptions were relatively limited. However, negative attitudes were increased during the studies.

Finally, to find out the stability of the attitudes in the selected context, the fourth research question of the study was formulated as follows: **"How does the academic year influence on the attitudes towards entrepreneurship?** And further: **"How do the attitudes of the student groups change between the different academic years?"**

METHODOLOGY

The study was conducted by using a questionnaire. It included 27 statements related to the four main themes to find out the students' attitudes towards entrepreneurship. The first theme was "Entrepreneurial features and characteristics" and it had nine variables of which some were related to personal traits and to some learnt abilities. The second theme was called "Entrepreneurial motives" and it had six variables. The third theme concerned "Interest for one's own enterprise" and it had four variables. Finally, the fourth theme was related to "Barriers of entrepreneurship" and it had eight variables. It is worth mentioning the following things about the questionnaire: all the 27 statements were in one list, not categorised according to the themes introduced above, and there were both positive and negative statements. Beside 27 statements (alternatives to answer were from 1 to 5), the

students were asked questions as background information, gender, academic year, and if there were entrepreneurs in their core family or in their acquaintances. Further, they were asked if they have thought about setting up their own business in the future, by giving five different alternatives to answer (see Table 1). However, it is worth mentioning that in this study entrepreneurial intention means the likelihood of starting a business in the near future (yet it does not refer to the intentional planned behavior, cf. Ajzen, 2001). The study was carried out in November - December 2009 and four different international student groups were selected in the sample (n = 106). The questionnaires were delivered to the students at the beginning of classes and the students were asked to answer the questions. The questionnaires were returned back as soon as they were answered by the students. In addition, two of the student groups had answered the same questionnaires in November 2008 already, therefore the development aspect of the attitudes was included in the study and the findings of the two groups (study group and reference group) were compared between the years 2008 and 2009 (see Table 1). In the study group, about 60% of the sample was female and 40% male students. They represented many different nationalities from all the continents. The group of international business students (IBC) was studying in Belgium as ERASMUS exchange students and they were from different European countries.

Table 1: Characteristics of the samples

Sample in 2009 (n = 106): <i>Variables</i>	<i>Categories</i>	<i>Number</i>	<i>%</i>
1. Academic year	First (BM1)	29	27.3%
	Second (BM2)	22	20.8%
	Third (BM3)	19	17.9%
	Third – Fourth (IBC)	36	34.0%
2. Gender	Male	42	40.0%
	Female	63	60.0%
	No answer	1	
3. Entrepreneurs in core family	Yes	58	55.8%
	No	46	44.2%
4. Entrepreneurs in acquaintances	Yes	72	68.6%
	No	33	31.4%
	No answer	1	
5. Entrepreneurial intention	Had not	8	7.7%
	Sometimes toyed with the idea and dreamed about it	61	58.7%
	Some plans already made	28	26.9%
	Already started a business or was a business owner	7	6.7%
	No answer	2	
Sample (reference group) in 2008 (n = 58):	1st academic year (is 2 nd in 2009)	39	67.2%
	2nd academic year (is 3 rd in 2009)	19	32.8%

The data analysis was made by using the SPSS-software. First, the frequencies, means and standard deviations were examined by each variable, and crosstabs were made. Then the means of the variables were combined as the combined variables according to the four themes introduced above. The correlation between the combined variables were examined and tested by using correlation analysis (Pearson) and the crosstabs by using Pearson Chi-Square tests. In addition, T-tests were used to test differences statistically between two student groups (Independent-Samples T-Test) and one-tailed variance analyses between several groups. Finally, the findings were reported according to the research questions of the study.

FINDINGS

Gender differences of entrepreneurial attitudes

The results for the gender differences of the attitudes are shown in Table 2. In comparison of the means of the variables, it seems that there are no big differences of the variables between male and female students. However, the differences were examined further and tested by using t-tests (Independent-Samples T-Test), and in six variables there were statistical differences between genders (see Table 2).

Table 2: Descriptive statistics of the means and T-tests by gender

Statements Note: the alternatives to answer were from 1 to 5, while 5 being correspond to the respondent's opinion very well	Male (n = 42) Mean / St.D	Female (n = 63) Mean / St.D	T-Test Sig. (2-tailed)
1. An entrepreneur holds an esteemed position in society	4.00 / 0.80	3.89 / 0.79	p = 0.482
2. An entrepreneur has the chance to be independent, his/her own master	4.33 / 0.85	4.29 / 0.77	p = 0.766
3. The entrepreneurial risk is not for me	2.17 / 0.93	2.52 / 1.06	p = 0.080
4. I like to work in changing circumstances	3.62 / 1.08	3.43 / 1.01	p = 0.360
5. It is no use becoming an entrepreneur without practical experience	3.32 / 1.35	3.83 / 1.14	p = 0.042*
6. You cannot educate yourself to entrepreneurship; it is a native talent or a trait learned at home	2.36 / 1.06	2.52 / 1.01	p = 0.419
7. An entrepreneur can affect his success with his own actions	4.45 / 0.67	4.27 / 0.83	p = 0.236
8. Entrepreneurship is interesting and challenging	4.51 / 0.71	4.24 / 0.80	p = 0.077
9. I would like to utilise my education in my own enterprise	4.29 / 0.74	3.63 / 1.20	p = 0.002**
10. My income level is better as an entrepreneur than in paid work	3.36 / 0.98	3.00 / 1.01	p = 0.078
11. Entrepreneurship takes all the time so there is not enough time left for the family or my own hobbies	3.12 / 0.99	3.29 / 1.02	p = 0.410
12. I cannot tolerate economic uncertainty	2.67 / 0.93	3.03 / 0.93	p = 0.052
13. As an entrepreneur I cannot develop myself enough	1.95 / 0.91	1.97 / 0.97	p = 0.093
14. As an entrepreneur the quality of life is better than if I would work in a paid job	3.36 / 1.10	2.78 / 0.94	p = 0.005**
15. My education does not support my becoming an entrepreneur	1.79 / 1.00	2.27 / 1.08	p = 0.023
16. Entrepreneurship just does not interest me	1.64 / 0.96	2.37 / 1.20	p = 0.001***
17. As an entrepreneur I have a chance to succeed	4.19 / 0.71	4.03 / 0.86	p = 0.323
18. I do not master the skills required in business	2.14 / 1.05	2.78 / 0.97	p = 0.002**
19. As an entrepreneur I could take responsibility for my work	4.50 / 0.74	4.32 / 0.78	p = 0.233
20. In my work I want to advance resolutely to the goals I have set	4.27 / 0.67	4.21 / 0.85	p = 0.694
21. I do not want to be responsible for the enterprise and its employees	1.88 / 0.95	2.30 / 1.24	p = 0.066
22. I would become an entrepreneur if a suitable opportunity would knock	4.43 / 0.80	3.79 / 0.94	p = 0.001***
23. An entrepreneur's life is nothing but toil	2.10 / 0.98	2.22 / 0.97	p = 0.516
24. If you work hard you can make it as an entrepreneur, too	4.02 / 1.20	3.79 / 1.11	p = 0.316
25. Being an entrepreneur, I could make independent decisions	4.40 / 0.70	4.16 / 0.70	p = 0.081
26. I want to work in a familiar and safe environment	3.57 / 0.97	3.71 / 1.18	p = 0.517
27. Entrepreneurs are usually doing quite well economically	3.38 / 1.06	3.26 / 0.90	p = 0.527

Significance limits: P < 0.001***, P < 0.01**, P < 0.05*

First, the difference of the statement 5 "no use of becoming an entrepreneurs without practical experience" was almost statistically significant (p = 0.042). The attitudes regarding the utilisation of one's own education in his own enterprise had a significant difference (p =

0.002) between genders. Then, in the attitudes concerning the better quality of the life as an entrepreneur than in paid work there was a significant difference ($p = 0.005$). In terms of interest, the difference was very significant ($p = 0.001$) between the male and female students. The difference of the attitudes related to the mastery of the skills required in business was significant ($p = 0.002$), and the difference of attitudes related to the statement of the "I would become an entrepreneur if a suitable opportunity would knock" was statistically very significant ($p = 0.001$).

Then, the variables were combined according to the themes (introduced in the methodology section) as four combined variables (means of the means) and they were compared between male and female students (see Table 3). The differences were statistically tested (independent-Samples T-Test) and the findings showed that there were statistically almost significant differences between the genders in the combined variables 2 and 3: according to the findings male students had more motivational factors ($p = 0.015$) as well as interest for their own entrepreneurship ($p = 0.025$). In addition, the difference was significant ($p = 0.025$) in the barriers of entrepreneurship: the male students had lower barriers of entrepreneurship than the female students.

Table 3: The combined variables by gender

	Male (n = 42)		Female (n = 63)		T-test Sig. (2-tailed)
	Mean	St.D.	Mean	St.D.	
1. Entrepreneurial features and characteristics	3.72	0.35	3.70	0.38	$p = 0.085$
2. Motivational factors for entrepreneurship	3.81	0.58	3.55	0.46	$p = \mathbf{0.015^*}$
3. Interest for one's own enterprise	3.71	0.44	3.51	0.46	$p = \mathbf{0.025^*}$
4. Barriers of entrepreneurship	2.31	0.55	2.65	0.54	$p = \mathbf{0.003^{**}}$

Significance limits: $P < 0.01^{**}$, $P < 0.05^*$

Entrepreneurial characteristics, interest, motives and barriers

The combined variables related to Entrepreneurial characteristics, interest, motives and barriers were tested by using correlation analysis (Pearson). First, Entrepreneurial features and characteristics and Entrepreneurial motives had an almost significant correlation ($r = 0.243$, $p = 0.015$). Entrepreneurial features and characteristics and Interest for one's own enterprise had a very significant correlation ($r = 0.322$, $p = 0.001$) with each other. Then, there was also a significant correlation ($r = 0.315$, $p = 0.002$) between entrepreneurial features and characteristics and motivational factors for entrepreneurship. In addition, an almost negative correlation ($r = -0.198$, $p = 0.049$) existed between Motivational factors for entrepreneurship and Barriers of entrepreneurship. Two-tailed Pearson correlations between the four combined variables are introduced in Table 4.

Entrepreneurial intention

Entrepreneurial intention was operationalised by giving four different alternatives to answer: No intention, Sometimes been in mind, Some plans already made, and Own business started already. The findings are presented together with the information of whether there is an entrepreneur in the core family or among the acquaintances of the respondent which were combined as one background (see Table 5). The findings illustrated that most of the students ($n = 90$) had an entrepreneur in the core family or among the acquaintances. Nevertheless, the differences were examined further and tested by using Pearson Chi-Square tests variable, but no statistical differences were found.

Table 4: Correlations between the combined variables

		1. Entrepreneurial features and characteristics	2. Motivational factors for e-ship	3. Interest for one's own enterprise	4. Barriers of e-ship
1. Entrepreneurial features and characteristics	Pearson Correlation				
	Sig. (2-tailed)				
	N	105			
2. Motivational factors for entrepreneurship	Pearson Correlation	0.243*			
	Sig. (2-tailed)	0.015			
	N	100	101		
3. Interest for one's own enterprise	Pearson Correlation	0.322**	0.315**		
	Sig. (2-tailed)	0.001	0.002		
	N	103	99	104	
4. Barriers of entrepreneurship	Pearson Correlation	0.184	-0.198*	-0.123	
	Sig. (2-tailed)	0.063	0.049	0.218	
	N	103	99	102	104

Note: **Correlation is significant at the 0.01 level (2-tailed), *Correlation is significant at the level 0.05 (2-tailed).

Table 5: Intention to start own business

	An entrepreneur in the core family (parents or siblings) or among acquaintances (relatives or friends)		Count
	Yes	No	
No intention	7	1	8
Sometimes been in mind	51	10	61
Some plans already made	25	4	29
Own business started	7	0	7
Count	90	15	105

Stability of attitudes

The findings related to the stability of attitudes are presented as combined variables in Table 6. Although the differences between the academic student groups were quite small, they were tested by using one-tailed variance analyses (ANOVA). Nevertheless, no statistically significant differences were found between the academic student groups.

Table 6: Combined variables by academic student groups

	BM1 (n = 29)	St.Dev	BM2 (n = 22)	St.Dev	BM3 (n = 19)	St.Dev	IBC34 (n = 36)	St.Dev	ANOVA Sig.
1. Entrepreneurial features and characteristics	3.70	0.374	3.78	0.502	3.58	0.353	3.73	0.250	p = 0.296
2. Motivational factors for entrepreneurship	3.76	0.489	3.61	0.675	3.50	0.535	3.68	0.438	p = 0.617
3. Interest for one's own enterprise	3.59	0.455	3.46	0.424	3.65	0.394	3.62	0.505	p = 0.335
4. Barriers of entrepreneurship	2.43	0.527	2.7	0.681	2.38	0.504	2.53	0.529	p = 0.142

Next, the development of the attitudes of two student groups between the years 2008 and 2009 is introduced. In order to understand the development in detail, the development of

the attitudes is introduced by the groups: Group A refers to a student group which started their studies in the autumn 2008 and group B refers to a student group which started their studies in the autumn 2007. In other words, the development of the attitudes demonstrates the development of the attitudes during the first and the second academic years as well as the development during the second and the third academic years (see Table 7).

Table 7: Development of the attitudes during two academic years

	BM1 (group A) in 2008	St.Dev	BM2 (group A) in 2009	St.Dev	BM2 (group B) in 2008	St.Dev	BM3 (group B) in 2009	St.Dev
1. Entrepreneurial features and characteristics	3.77	0.34	3.78	0.50	3.68	0.37	3.58	0.35
2. Motivational factors for entrepreneurship	3.63	0.65	3.61	0.68	3.43	0.41	3.50	0.54
3. Interest for one's own enterprise	3.65	0.46	3.46	0.42	3.66	0.31	3.65	0.39
4. Barriers of entrepreneurship	2.34	0.54	2.70	0.68	2.46	0.62	2.38	0.50

Finally, the findings were also tested: first as the separate study groups A and B between the academic years, then together as one group between the academic years. However, no statistical differences were found. Nevertheless, it is worth mentioning two things related to the findings: first, there is a small change of attitudes in all variables between the first and the second year (the means of three first variables decreased and the mean of the barriers of entrepreneurship increased). Secondly, there was also a small change in the findings between the second and the third academic year, yet in a different way from the first and the second academic years. In terms of Entrepreneurial features and characteristics the means decreased, the means of Motivational factors for entrepreneurship increased, Interest for one's own entrepreneurship remained the same, and Barriers of entrepreneurship decreased to some extent. Although there were no statistical differences, however the findings might indicate the nature of the changes in the context.

DISCUSSION

The main findings of the study

In order to answer how the gender influences the attitudes towards entrepreneurship in the selected context, it can be summarised that the findings indicated that the male students did not have more entrepreneurial features than the female students. However, they have more motivational factors and interest for entrepreneurship than the female students, which supports Urbano's (2006) as well as Kundu and Rani's (2008) research results. In addition, the barriers of entrepreneurship are lower for the male students than for the female students. Based on the findings it can be concluded that the entrepreneurial features and characteristics are positively related to the interest for one's own enterprise as well as the entrepreneurial motives. In addition, motivational factors for entrepreneurship are negatively related to the barriers of entrepreneurship. The findings illustrated that even if there was an entrepreneur in the core family or among acquaintances, it had no statistically significant influence on the perceived entrepreneurial intention of the international students (cf. Urbano 2006; Degeorge & Fayolle 2008). Further, in order to summarise the findings related to the development of attitudes, it seems that they do not differ between the academic study

groups or between the study years, but remain almost the same. This supports also the theory that strong attitudes are expected to be relatively stable over time (Ajzen, 2001).

Limitations of the study

The findings of this study improved the understanding of international business students' attitudes. However, there are limitations of the study which should be taken into consideration. First, the size of the sample was rather limited; therefore the findings should be generalized carefully. Another limitation of the study is related to the development aspect: in order to understand the stability or potential changes of the attitudes better, the development of the attitudes should be followed longer, from the beginning of the studies to the graduation of the students in order to have a better understanding of the development.

Thus, although the findings helped to answer the research questions, many other questions remain, and it provides possibilities for further studies. For example, a longitudinal study covering several international business programmes both in Finland and in other countries might be useful in understanding and explaining the topic. In addition, a follow up study for the graduates would better reveal both the attitudes and intentions of the students a couple of years after the graduation. It might also be worth to examine the attitudes and intentions of those students who have really started their own business during the studies or just after their graduation.

Implications and conclusions

The findings can be pondered and conclusions can be drawn from the point of view of the students and teachers, but also from the point of view of society in general. First of all, in terms of scientific contribution, it can be concluded that the findings support quite well many previous studies related to attitudes and entrepreneurial intention. The findings of this study revealed the attitudes and entrepreneurial intention of international students. Further, since attitudes affect and predict intentions which, in turn, predict behaviour (Ajzen, 2001; Krueger & Carsrud, 1993), it can be concluded that the findings indicated that the entrepreneurial attitudes of the international business students are quite positive. It means that they might have a real intention for setting up their own businesses later. It could be taken into consideration and supported during their studies.

However, based on the previous studies as well as the findings of this study, the attitudes seem to be rather stable during the studies in higher education, which can be concluded in two different ways: depending on the aims of entrepreneurship education in an university, the attitudes could be taken more into consideration while selecting students carefully for entrepreneurship training, based on their attitudes towards entrepreneurship, and provide the training especially for them. On the other hand, if the aim is to increase the more effort could be put on the promotion of all the dimensions of entrepreneurship before and during the studies in higher education.

In general, although the attitudes seem to remain stable during the studies in higher education, the level of them is what accounts. In fact, in order to influence the attitudes, the promotion activities should be taken up much earlier by the society through up-bringing and basic studies. All in all, how to affect and promote entrepreneurial attitudes is still a big practical challenge both for the education and also for the business life.

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THE IMPACT OF THE INCUBATORS' ROLE ON THE FIRM'S DEVELOPMENT IN THE BIOTECHNOLOGICAL SECTOR. AN EMPIRICAL ANALYSIS OF THE PIEDMONT REALITY

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Abstract

The development of the innovative activities in Italy is characterized by a limited presence of start up, if compared to what has been happening abroad. This fact, combined to the strong European request of reducing the entrepreneurial risk and the major attention to what is called "life science", has started off biotechnological clusters. Moreover, in these latest years, the tendency has been to promote the international relations to favor the territorial technological development.

The aim of our empirical research is to analyze the structure of the Turin (Piedmont Region) biotechnological cluster, in which the ideas' and firms' Incubators have a decisive role in terms of start up's promotion, raise, development and technological and knowledge transfer between the academic reality and the entrepreneurial one. Besides, we also want to analyze

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how the Incubators can be fundamental in order to attract capitals, both private funds and public ones.

Keywords: Biotechnological cluster; Incubators; Innovative activities; Start up

Topics: Industry and area specific studies; Technology and innovation management; Natural sciences and business

INTRODUCTION

"Biotechnology is the application of scientific and engineering principles to the processing of materials by biological agents to provide goods and services" (OECD, 2003).

Biotechnological companies arose in the '80s with the aim of capitalizing on their biotechnological discoveries in the pharmaceutical field. Fundamental forces shaping the biotechnology industry in the first decade of the 21st century include (Ahn, Meeks, 2008): 1) the gap between the low cost of creating a biotech company and the high costs for the pharmaceutical companies of converting novel technologies into approved drugs; 2) a steady evolution of the perception of value by investors in the biopharmaceutical industry value chain; 3) the irregular nature of the biotechnology financial markets resulting in increased operating risk and uncertainty; and 4) demand by multinational pharmaceutical companies for a product pipeline to insure against their own declining productivity and growing market penetration by generics.

The biotechnological companies are, on average, smaller than the pharmaceutical ones, and they have made the latter's position more fragile in the drug discovery phase (that is, in the first phase of research). Nevertheless, biotechnological companies are weak at the commercial distribution level.

THE STRUCTURE OF THE TURIN BIOTECHNOLOGICAL CLUSTER

In field of biotechnology, 75% of Italian firms born on solid scientific base like start up of researchers or academic spin off. However more than half of those firms, after some years is not able to earn more than one million euro gross.

Even in Italy it is possible to find out territory with a strong interest for biotechnological development. It is possible to notice the presence of biotech clusters characterized by the presence of a biopark, private firms, public laboratories, incubators and attracting a strong interest in biotech research of public institutions, in addition to the one of private firms. The biotechnological research is so composed: bioinfo 4%; environmental 9%; agrifood 14%; health 73%.

In Italy, as in other European countries, innovative activities in biotechnology have lagged significantly behind the U.S.A. and proceeded along different lines. Structural weaknesses in the industrial base, in the research system, and at the institutional level have hindered the development of biotechnology. The most important difference is the virtual absence of the phenomenon of the specialized biotechnology start-ups, even as compared to other European countries (Orsenigo, 2001).

The concept of cluster can be traced back since to 1920 with the work of Marshall in 1920 on the English industrial regions of the 19th century, observing which focused on the creation of industrial districts. Even Porter (1998) states that: "Clusters are geographic concentrations of

interconnected companies and institutions in a particular field"⁴. More specifically, cluster initiatives are a particular form of public-private partnerships and are organized collaborations between public and private sector actors, such as firms, government agencies, and academic institutions, with for the purpose of enhancing the growth and competitiveness of clusters (Teigland, Lindqvist, 2005).

In the future biotech clusters are expected to move away from geographical regions and become more virtually based around diseases, pathways, markets and unique industry segments.

The biotech cluster: the raise and the business model.

The Piedmont reality is characterized by the presence of the Turin biotechnological cluster. Its structure is organized in two principle areas: the University of Turin and the Bioindustry Park in Ivrea (in Turin province).

Inside the University of Turin there are the 2i3T Incubator and the Ideas' Incubator of the Molecular Biotechnology Center (MBC).

Bioindustry Park in the Canavese area is a scientific Park specialized in Life sciences, is the second one in terms of size and importance in Italy. It has been established near Ivrea, Turin county, and is operating since 1998 (Eporgen, 2009).

It has been created in the context of structural funds for the regional development managed by Piedmont Region which gave a total amount of 32 million of Euros for the infrastructures. The Bioindustry Park has been thought as a tool to the economic requalification of the territory and the its management is always involved in the international development; for example the park is involved in an international project called Bio Alps, born five years ago. The aim of this initiative is to cooperate managing complementary assets coming from Italy (Piedmont and Lombardy), France (Grenoble) and Genève. The first goal is the events' organization, the second one concerns the matching between firms and research centers and the third one is about the students' exchange.

Within the social whole are presents the following public organizations and private firms (The corporate is BiPCA corporation, with more than 8 million euro of capital. This society coordinate directly the realization of investments): Finpiemonte S.p.A; Provincia di Torino; Istituto di Ricerca Cesare Serono S.p.A.; Merck Serono – RBM; Telecom Italia SpA; Bioline Diagnostici srl; Confindustria Canavese; Confindustria Piemonte; Bracco Imaging; Camera di Commercio di Torino.

As wrote before the infrastructures have been financed by the Public sector and every year the Region gives funding to the biotech pole for specific projects about specific researches and what is called technology transfer; if 100 are the costs of the Bioinsutry Park, 50 usually come from the Region and the rest from the self – financing (25% from the facilities rent, 25% from consultant activities). The total amount of the 2009 revenues was 6 million Euros; moreover the Park doesn't receive funding in the profit and loss account and when the

⁴ Three kinds of advantages are also identified by Porter (1998): productivity advantages (reduction of transaction costs), innovation advantages (biotech clusters that mostly mainly arose near research centers of excellence in biotechnology-based disciplines), and new business advantages (the role of environment in the creation of new biotech companies). Prevezer and Stout (1998) identify other advantages concerning the demand side: input-output multipliers (strong local demand), hostelling (spatial competition), search costs, and information externalities (transfer of tacit knowledge between people working within a cluster. On the supply side, major advantages are: technology spillovers, specialized labor and, infrastructures.

Region or the Public Administration finances the park, it concerns a co-financing that means that the amount of the fund given by the public is about the 60%; the Bioindustry invests the remaining 40% (self-financing).

In details the Park offers to the recently established firms operating in high tech sectors a complete kit of services which facilitate the start up and spin off in the pre-start up phase (feasibility studies and selection of projects) in the start up phase (assistance in business planning, legal assistance, support in fund raising activities and/or partner research like venture capital or business angels) for the development (support in the start up phase, orientation and financial, legal, fiscal, technological and marketing assistance, in the 3-5 years of stay in the bio-incubator) and finally Way-Out (verify of results, orientation for the realization of a business plan of development, research of partner able to support the competitive development of the firm on the market).

Talking about startups, we have to consider Eporgen Venture which is the first Italian company, entirely funded by private, non-institutional investors, dedicated to seed capital investments in the area of life sciences. It was established in June 2004 with the aim of establishing and supporting the development of new enterprises operating in the life sciences field and born of highly innovative projects of international scientific importance. To date, Eporgen - this venture raises just private funds - has no less than 11 investments on its financial balance sheet, 10 of which are start-up companies and 1 pre-funded project that is ready to become a start-up company during the course of 2009. From 2005 Eporgen has been gathering more than 6 million of Euros.

THE INCUBATORS' ROLE OF THE TURIN'S BIOTECHNOLOGICAL CLUSTER

The incubators arise to offer means for favoring growth and the success of firms through a network of resources and support services for business activities; they make available the sites, basic logistical services, and the networks of personal contacts that form as a result of carrying out business activities in a single structure. The most well-equipped incubators also provide managerial services and technical, legal and tax consulting.

Nevertheless, incubators represent a temporary solution, since usually the authorization to carry out business activities in an incubator is year-to-year, and in any event limited to a maximum of 3-5 years. After the start-up phase the business, if successful, is transferred outside the incubator into an independent structure, thereby completing a process for the creation of new businesses, employment, and regional and national economic stimulus.

Many incubators were formed in Europe when, in 1984, the European Commission decided to favor measures aimed at developing business enterprises in member countries. These incubators were all of the BIC (Business Innovation Centre) type, with public capital, and aimed at providing local enterprises a set of basic services: spaces in which to operate, logistical infrastructures, communication channels, and opportunities for outside financing. Subsequently, the private capital and for-profit incubators began to spread.

Often the incubators are in scientific and technological parks; that is, geographic poles that enhance the advantages from the joint localization of firms and institutions such as universities, venture capitalist associations, etc., operating in high-tech and knowledge-based sectors.

The growth of start-ups is the result of the entrepreneurial spirit of one or more individuals with innovative ideas. Both in the U.S. and the European Union the founders generally come

from the university or public research sectors, on the one hand, or the laboratories of large enterprises on the other. We can thus speak of academic or industrial spin-offs.

As concerns the academic spin-offs, after the university in question has obtained approval from the competent authorities and the patents, it can license (though it is not bound by this) its intellectual property to start-ups that include its own researchers or former doctoral students, thereby acquiring royalties on the revenues or sales, or participating in the equity.

While industrial spin-offs can occur for different reasons, in general they are closely linked to the transference of research from the pharmaceutical companies to the biotechnological ones, or as a result of rationalization processes or merger and acquisition operations.

The 2i3T Incubator of the University of Turin is a company where the University, Provincia di Torino, Comune di Torino and FinPiemonte each owns 25% of the company's stock. The company capital amounts to 50.000 euro and it is entirely given.

The innovation poles are synergic coordination tools among different players of the innovative process, with the aim to make available high value added infrastructures and services and to interpret the technological demands of the enterprises to address the regional actions that support research and innovation. Focused on specific sectors, the poles will be constituted by groupings of enterprises, organisms of research and from a corporate body manager.

Fig. 1 - Turin start ups sample

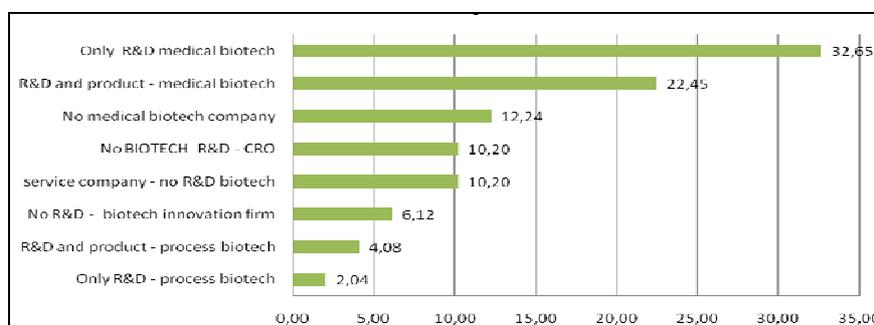


Fig. 2 - Medical research – specific area

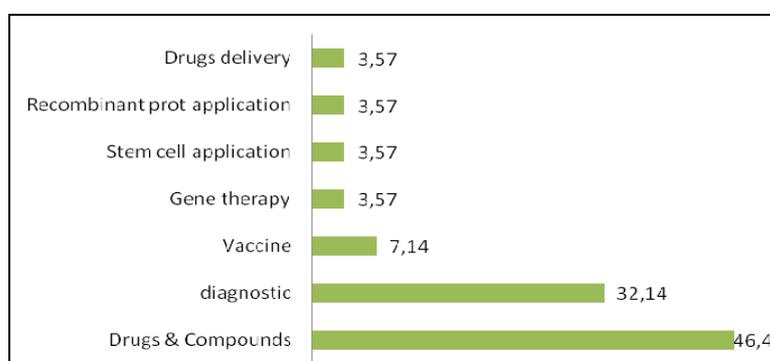


Fig. 3 - *Process technology – specific area*



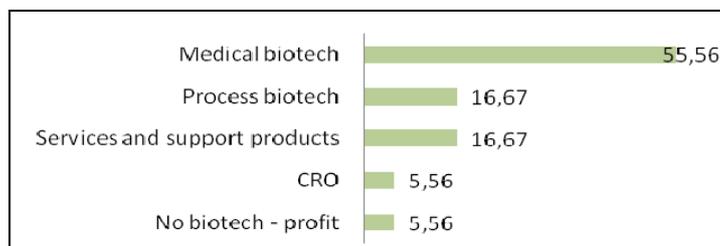
Sources: authors'elaboration

The incubator has shown its own interest into the poles of the *sustainable chemistry*, of the *biotechnology* and *biomedical*, of the *new materials* and of the *agrifood*, with the finality to propose itself as a subject bidder of technologies and know ledges, to promote the know how of the incubated enterprises and the university groups of research, particularly of those which pertain the available instrumentations into the incubator. The reality of the incubator doesn't have proper assets because these are of the university. In Turin there is also the ideas' incubator inside the Molecular Biotechnology Center of the University of Turin for specifically biotechnology research requested by external subjects or firms.

Unlike the Turin reality, in Ivrea we can find a facilities system called Discovery; this represents the second step of the biggest project realized into the Piedmont Region DOCUP 2000-2006 context and this is the incubator; this system of facilities offers 9 spaces equipped for the same number of startups operating in Life sciences, besides common equipping and areas.

The newly established startups companies can set themselves up within this incubator and thereby, during their first three years of life, enjoy the benefits of subsidized rentals, communal areas equipped with the most advanced instruments and privileged access to the technical and scientific skills of the Inter-disciplinary Advanced Methodology Laboratories (LIMA), in which the Bioindustry Park conducts its own proprietary projects and others on a contract basis, aimed at technology transfer. Furthermore, thanks to its network of international scientific and institutional contacts, the Bioindustry Park is able to provide the start-up companies with significant support in terms of sourcing and accessing public funding both within Italy and in Europe.

Fig. 4 - *Ivrea's start ups sample*



Sources: authors'elaboration

Fig. 5 - *Ivrea start ups*

Startups	activities
Apavadis Biotechnologies s.r.l.	Profit, just R&D of biotech process; proteomic anticancer
Bionucleon s.r.l.	Profit, just R&D biomedic product; drugs & compounds no specific therapeutic area
Biopaint s.r.l.	Altro per profit, no R&D biotech, environmental bioremediation
Creabilis Therapeutics s.p.a	Profit, R&D e commerce biomedic product, drugs & compounds, dermatologic
Dirivet Imaging	Altro per profit, no R&D biotech, services company
Ephoran Multi Imaging Solutions	Profit, just R&D biotech process; diagnostic no specific therapeutic area
Genovax s.r.l.	Profit, just R&D biomedic product; vaccine no specific therapeutic area
Natimab Therapeutics s.r.l.	Profit, R&D e commerce biomedic product, antibody no specific therapeutic area
NoToPharm s.r.l.	Profit, just R&D biomedic product; dignostici autoimmune disease
Spider Biotech s.r.l.	Profit, R&D and commerce biomedic product, drugs & compounds, anti infective
Target Heart Biotec s.r.l.	Profit, R&D e commerce di biomedic product, drugs & compounds, cardiovascular
Vanadis	no R&D biotech, services and support products
Narvalus s.r.l.	Profit, R&D commerce biotech process, cells colture cell no specific therapeutic area
Rotalactis	Profit, R&D commerce biomedic product, drugs & compounds, metabolic/foodstuff
Noraybio	no R&D biotech, services and support products
ProCellTech	no R&D biotech, CRO
Glyconova	Profit, R&D commerce biomedic product, drugs & compounds, anticancer

Sources: authors'elaboration

If we want to compare the Turin incubator 2i3T and the Ivrea one, we can say that the first one is a legal subject, the second one is an concept; this is a concept and not a project because the project usually has one begin and one end, the concept has one begin but has not end. Finally, the Ivrea incubator is a way to do, a behavior in which we can count the 11 Eporgen startups plus 4 or 5 others companies.

Talking about the Eporgen reality, it has been started as a Bioindustry Park initiative to help the startups' incubation; before the raise of Eporgen, there was a lack of private capital to invest in startups and the Park Board took the decision of creating an independent venture; a company which have the total amount of the corporation stock as private. Eporgen Venture is though as a tool to help startups raising and growing but only if they are driven by winning ideas. This approach has the main goal of avoiding what the Park Board calls "initiative's parasitism".

The Eporgen business model is a smart one; even if in the Piedmont Region territory we cannot find business angels specialized in biotechnology, we can find business angels in other sectors able to invest money in winning initiatives; so the Eporgen goal is to get them around a table for guarantee the biotech sector knowledge. The approach is not the business angels typical one because the investment which is proposed by Eporgen is the portfolio one; business angels will not invest in just one startup but in a startups' portfolio.

The choice of the portfolio startups was managed with an extreme selection through a two years national public job advertisement; the planning ideas was been garnered and selected thought a two step process (internal and external the Park) and this process has involved three venture capitalists and three industrial specialists coming from the Serono reality. A third step was based on another internal analysis and, after that, Eporgen was able to define the startups to incubate.

During the latest 10 years the Bioindustry Park has helped more than 30 companies to raise and to grow, gathering more or less 30 million Euros of equity and this is a great result if compared to the youth of the Ivrea biotech reality. Moreover, it is important to analyze that we are talking about funds given directly to the startups, not to the biotech park by which

today the Piedmont Region has seen the birth of a new sector (to remind: at the begin of the 21th century, there weren't biotech firms in this Region).

Incubators' promotion and the technology transfer.

These incubators have a fundamental role on the firm's development in the biotechnological sector. In particular they promote the born and the development of the biotechnology start up in the Piedmont territory. Every incubator has own distinctive features that can be summarized as the following.

The incubator of the University of Turin 2i3T is place of aggregation of entrepreneurial activities that, thanks to its facility of contact and interchange consequential from the concentration in one unique center, it should offer an articulated and complementary set of services able to accelerate its development⁵. The 2i3T revenues refer to the charges for services provided for enterprises incubated in example for the use of scientific equipments and of laboratories. It can therefore result useful to plan a process of incubation of the enterprises articulated in the following phases: promotion, tutorial ex-ante the constitution, tutorial ex-ante the constitution, scouting, idea definition, business plan formation and development, the constitution of the enterprise, tutorial ex-post constitution, incubation in 2i3T and acceleration process.

The ideas' incubator inside the Molecular Biotechnology Center of the University of Turin has not a formal procedure for the incubation process. The subjects or firms that request the incubation pay a rent for the infrastructure, instrumentation and machinery.

As told before, the incubator Discovery is a concept and every promotion and technology transfer action is something the Bioindustry Park management has to think about; the international initiatives, the events and the students exchange programs are some examples.

The attracting capitals capability.

A central role is taken by co-financing program of the public sector, contributing for more than 50% in favor of the smallest firms with national and regional programs. About Venture Capital, it is confirmed their scarce presence on national market. Finally, result almost absents even the so called Business angels.

Financing for biotechnological research can take the form of public financing, for-profit private financing, and non-profit private financing. Public financing can be direct or else take the form of company incubators.

Public financing for companies in the biotech field is distributed through various formulas based on the country in question.

Finally, as regards private financing, bank financing for unlisted companies is generally possible in the biotech sector only for those companies that can offer immaterial fixed assets as a guarantee. Other sources of private financing for unlisted firms are seed money in the form of business angels, venture capital, private equity funds, and corporate venturing. The 2i3T incubator and the startups receive regional and European funds for the development of their own activities.

⁵ Serrao G. in G. Büchi, C.A. Di Fazio, M. Pellicelli (a cura di), 2008, *Economia aziendale. Temi e metodi per le Facoltà scientifiche*, FrancoAngeli, Milano.

Also the future startups can participate to the "Start Cup Torino Piemonte"⁶ competition that chooses the more innovative ideas and reward the best ones. Moreover this is a fundamentals moment for connecting the new ideas and the investors (business angels, seed capitalist, etc).

From the Ivrea pole side, the Eporgen system is a great one in raising times and this system is suffering the crisis situation; the Eporgen planning needed about 10 million of Euros but this funding not happened so in 2010 maybe some startups could be closed. Meanwhile Piemontech⁷ has been involved in this system and has invested in two incubated startups.

Nevertheless there is a systemic problem which regards the venture capital; in Italy is difficult to find investors in life sciences sector and this is true not just for Italian investor, but also for foreign investors and this happens because the biotech in Italy is perceived as too risky unlike what has been happening abroad since years.

If we look at the France reality, for example, we can see that the Grenoble biotech cluster can count on three risk funding levels; a "pre-seed" level (50.000-100.000 Euros), a 10 million Euros fund, a 25 million Euros venture capitalists level. So Grenoble can count on more than 35 million Euros against the 6 million of the Bioindustry Park; there is the difference.

CONCLUSIONS

The limit of our research has been represented by the difficulty in analyzing start ups' data – in particular the economics ones because the neo-entrepreneurs (often scientists at the first years of activity) have not developed the entrepreneurial mentality and they have many difficulties when they have to outline their own firms' economic trends. Despite this limit, we could understand as follows.

The Bioindustry Park and its incubator and 2i3T are so closed, that it's easy to think about synergies between the Ivrea pole and the University of Study of Turin. Actually some University Departments 'activities are placed on the Bioindustry Park ground, as some MBC research's groups and the focus is on the molecular imaging; what must be said is that those synergies are there because off some University full professors interests, so we are not talking about systematic behaviors.

However thanks to the bridge built between Ivrea and Turin, in the latest years a first molecular imaging center has been built in Ivrea. Through it the Ivrea reality makes the entrepreneurial competencies available and the University of Turin (with its Departments and the MBC) does the same with the academic ones.

This is, at the moment, the visible synergy; moreover the Bioindustry Park and 2i3T incubator are starting working together in some international initiatives and European projects, as the ESOF 2010, which is the biennial pan-European meeting dedicated to scientific research and innovation (planned for July 2010 in Turin).

Certainly the collaboration should be huger. The two realities don't work together on initiatives as the startups 'catching, neither on the ideas' selection, nor on the support services. Why? It seems due to the different cultures, different DNAs; in Ivrea we can smell

⁶ Start Cup is a an entrepreneurial project competition addressed to all those who have an innovative business ideas. the focus is on the innovations which can bring new features to products, processes and businesses.

⁷ The holding company promoted by the Torino Wireless Foundation, invests with risk capital in the most promising Piedmont-based companies in the following sectors: Information and Communications Technologies (ICT), Biotechnologies, Biomedics, Advanced Mechanics, Energy, innovative Services. Source: www.piemontech.it.

an entrepreneurial culture, while in Turin the culture is mastered by the university mentality. The only result is that they perceive each other as competitors in terms of funds and, more in general, money and this is the biggest systemic error which can represent an obstacle to the Piedmont international competitiveness.

Another difference we have to underline is the composition of the equity; when we talk about the Bioindustry Park we look at a model in which the Region and the Public Administration have the 70% of the share against the 30% owned by Merck Serono, Bracco and the other private firms.

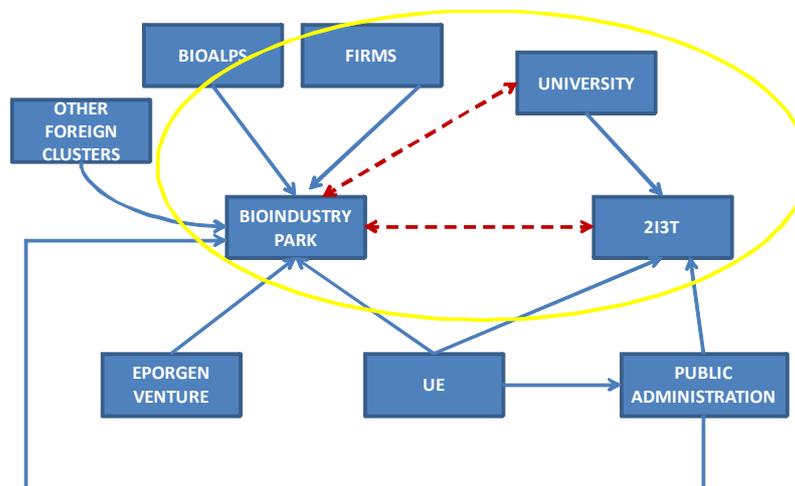
Although we have to consider that the Piedmont reality is one of the more fast growing; the Bioindustry Park is getting a benchmark for the other rising biotech Italian clusters (as the ones in other Italian Regions as Sicilia and in Puglia).

Finally we should consider some elements in order to improve the success of Piedmonts Incubators and biotech clusters.

Concerning our research, today the Bioindustry Park (in which we can find the Ivrea incubator) is the player with the major number of international relationships (as the Bio Alps can show); moreover is managed through a business model like what we can find abroad (for example in the Genopole bio cluster, France)⁸.

According to the model below, a huger collaboration between the BioindustryPark and 2i3t incubator (red dotted line in the model) should take international advantages, because the Ivrea pole's relationships would mean a huger international visibility for the Turin start ups which, at the moment, have few possibilities to be known by foreign investors and backers.

Fig.6 - *Synergies and relationships among the biotech sector's players*



Sources: authors' elaboration

We have to underline that in Italy there is a broad limitation for the development of the biotech young realities: investors don't pay attention to the innovative sector because they perceive it as too risky. A major synergy between Ivrea and Turin would create active networks for business angels or informal investors for an increase of very early stage high risk investment capital; this would mean profit not just for the single start ups, but for the

⁸ To decide about the new start up, the bio park board evaluate the single cases using the BCG matrix; in this way it is possible to understand the research areas the territory mostly needs.

whole territory as well. Moreover, public and private financing mechanisms and other financial incentives are needed to attract private investors to invest in client firms in the incubation process and in the cluster's territory.

Eventually, thanks to a huger collaboration between the two realities, it would be easier the alignment between the entrepreneurship in one hand and the university research in the other hand. This alignment can be generated by building the tools for an everlasting communication among researchers (the University of Turin is one of the shareholders of the 2i3t) and the two analyzed poles' firms. This could be a very useful link because another huge limitation is represented by the lack of managers who have proper biotech skills, in one hand, and can manage corporate and business problems, in the other hand; a collaboration among university's researcher and entrepreneurs is fundamental because the incubators need to develop a multidisciplinary culture of staff to guarantee a support on the competences needed such as coaching, marketing, accounting and (if applicable) supervision, available for client firms.

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