Measuring Italian university efficiency: a non-parametric approach

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Abstract

This work analyses the performance of Italian universities taking into account technical efficiency. The study provides an assessment of levels of technical efficiency taking into account also environmental factors. We focus on the relationship between levels of technical efficiency and university students dropouts. The efficiency analysis, using Data Envelopment Analysis, w.r.t. the 2009/10 academic year, shows that universities belonging to the private sector have higher efficiency scores than public owned universities. Moreover, a difference arises on a geographical basis where centre-northern universities are generally more efficient than southern ones.

Keywords: Technical efficiency – DEA – Second stage analysis

JEL Classification: I21 – I23 – C14

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1. Introduction

In this paper we provide an assessment of levels of technical efficiency in university education among Italian universities and, subsequently, analyze the environmental factors which may justify different levels of technical efficiency. In particular, we examine the relationship between levels of technical efficiency and choices of university dropout. Therefore, we will estimate technical efficiency of Italian universities applying Data Envelopment Analysis (DEA) on data collected by the National Evaluation Committee (CNVSU), relative to the academic year 2009/10.

Moreover, different levels of technical efficiency achieved by the universities may be influenced by several factors independent of the management efforts of the universities themselves, such as environmental conditions that may have a different impact on academic institutions. To further understand the effect of these factors we carry on a second stage analysis, by regressing the efficiency scores on some environmental variables.

The structure of the paper is as follows. In section 2 we present a small literature review, in section 3 and 4 data will be presented as well as a description of Italian university indicators. In section 5, DEA analysis will be carried out. Then, in section 6, we will analyse factors affecting efficiency. Conclusions and remarks will follow.

2. Literature review

Efficiency measurements of higher education institutions can be carried out through various techniques and approaches, in relation to the object of analysis and the characteristics of organizations to be studied.

In the production process of education, universities jointly employ many inputs and outputs; inputs are represented by fixed assets (real estate, equipment), employees (academic and non-academic staff), raw materials (energy, material for teaching), while outputs can be expressed by the number of graduates (which can be used as a proxy of the teaching performance) or by the amount of external resources attracted to research activities (as a proxy for research performance (Agasisti and Perez-Esparelles, 2010).

Early studies on universities' performance are based on OLS regression analysis, in order to investigate variations in the outputs of different universities in relation to variations in a reduced number of inputs (Johnes and Taylor, 1990). However, since higher education systems are characterized by the existence of a multiplicity of input and output that take part in the production process, regression analysis seem to be unsuitable for the study of the performance (Johnes, 2006) and have been replaced by more effective methods, such as stochastic frontier analysis and Data Envelopment Analysis.

In addition, in some cases, availability of individual level data (due to more effective detection systems by administrative bodies) has made possible a more detailed study on the results achieved by students in the educational process (Johnes, 2006). In this regard, analysis that use data relating to individual students show that the outcomes of education depend on a number of characteristics of both universities, and students.

Furthermore, it has been shown that, taken into account the significant determinants of the chosen output, there are little differences in the performance between universities. Only a small number of them at either extreme have a significantly different performance with respect to the average (Smith *et al*., 2000; Smith e Naylor, 2001; Johnes, 2006).

Finally, much of empirical studies on university efficiency focus on individual institutions, basing their analysis on academic departments (Johnes and Johnes, 1993, 1995, Beasley, 1995, Madden *et al*., 1997). Another branch of research concerns the efficiency analysis of the whole university system, by both studying individual universities (Johnes, 2006), and comparing universities in different countries (Agasisti and Johnes, 2009).

Among studies using the DEA to analyze the universities as a whole, we remind Breu and Raab (1994) and Johnes (2006). Breu and Raab (1994) apply the DEA to measure relative efficiency of the top 25 universities in the United States[1]. They find that the most prestigious universities always generate a high level of satisfaction among students. The authors finally conclude by suggesting that university expenditures should be aimed more at increasing levels of efficiency, rather than to improve the perceived quality. Johnes (2006) makes an analysis based on a data set consisting of 2547 graduates in 1993 from the British faculties of economics, in order to evaluate the efficiency of teaching.

Studies that analyse the university also make a comparison between university systems of different countries. Note that, in case of cross-country analysis, problems may arise. They are related to the difficulty to obtain comparable data between the different countries considered (Salerno, 2003) which, eventually, limits the scope of investigation. Joumady and Ris (2005) carry out a comparison between the universities of different countries, based on responses from young graduates in a survey. Analysis estimates efficiency of 209 universities belonging to 8 European countries.

Another comparative work has been done by Agasisti and Johnes (2009), in order to compare the university technical efficiency in Italy and the United Kingdom. Results appear to demonstrate that British universities are more efficient than Italian universities. Agasisti and Pérez-Esparrells (2010) conduct an efficiency analysis of Italian and Spanish universities, they consider a comparative perspective as well. Results are various. Basing the analysis on 'country-specific' frontier, each of the two countries has a good average efficiency in higher education. While, when compared together, Italian universities seem relatively more efficient than Spanish.

For a more complete overview on literature see Monaco (2011).

3. The Italian university system

The National Committee for the Evaluation of the University System (CNVSU) of the "Ministero dell'Università e della Ricerca Scientifica" (MIUR, i.e. Ministry of University and Scientific Research) publishes an annual "Report on the State University

[1] As classified by *U.S. News and World Report-ranked universities.*

System" which presents a detailed analysis on the state of the Italian university system, focusing on issues which affect demand and the provision of training, on aspects related to the management of human and financial resources, and on analyses of the rank of Italian universities in an international perspective. Information from the report represents a valuable tool for analyzing the growth prospects of the system.

In 2011 issue of the Report, referring to the academic year 2008/09, it has been noted a decline in non-enrollment to the second year of academic courses. Dropouts who were equal to 17.5 percent in the previous year (2007/08) decreased to 16.7 percent in academic year 2008/09, although this percentage is still high if compared to other OECD nations, so we need to implement a more effective guidance and mentoring to new inputs. As regards to first year inactive students (i.e. first enrolled students who did not get credits in the last calendar year) the number of those has grown over the previous year, arising from 12.5 to 13.3 percent.

Moreover, during the academic year 2008/09, the 13.6 percent of students in the three-year degrees has not acquired any credit, while inactive students in the previous academic year were 17.1 percent.

Furthermore, inactive students were fewer compared to the academic year 2007/08 also among those enrolled in *lauree specialistiche* and *magistrali a ciclo unico* (which are 5-years courses and 2-year post-graduate courses), data shows a percentage of 10.3 in 2007/08 and 9.2 in 2008/09.

Table 1 shows indicators relating to inactive students by faculty in the academic year 2008/09. Data reveals that students of the faculties of architecture and medicine and surgery have the best performance with respect to the phenomenon of missing entries and inactivity. In fact, for the faculty of medicine and surgery only 5.5 percent of the students decided not to enroll in the second year and, as regards to first year students, only 7.5 percent did not acquire credits. Probably, this evidence is explained by the restriction of admission to the courses, so that the submission of tests for entry allows selecting students more motivated and capable. At the other extreme there are the faculties of veterinary science and law that, as Table 1 shows, have, respectively, the highest number of missing entries in the second year (36.6 percent) and inactive students (30 percent).

Table 1 – Statistics on Faculties

Faculties	Number of regular students on total enrolled students	Dropouts in first year	Inactive first year enrolled students	Inactive enrolled students
Agricultural Sciences	56,4	22,6	20,6	20,1
Architecture	62,4	8,7	8,1	11,9
Economics	64,2	17,3	17,0	17,0
Pharmacology	57,1	31,3	19,0	21,5
Law	34,8	24,8	24,9	30,0
Engineering	58,5	18,1	17,3	19,9
Philosophy/Literature	56,3	17,2	17,7	17,6
Language and Culture	63,7	15,4	12,6	13,7
Veterinary science	62,7	36,6	25,9	21,6
Medicine	76,2	5,5	7,5	9,8
Psychology	60,6	8,4	14,7	16,3
Political Sciences	57,0	27,0	17,7	18,7
Educations Sciences	57,2	18,8	21,0	18,2
Mathematical and Physical Sciences	60,3	27,9	18,9	18,1
Sport Sciences	65,3	20,3	16,6	16,5
Statistical Sciences	68,7	17,5	15,0	20,2
Social Sciences	54,2	16,3	18,9	17,0

Source: “Undicesimo Rapporto sullo Stato del Sistema Universitario”, CNVSU, 2011

4. The dataset

Our analysis intends to make a first assessment on the impact of environmental factors and, in particular, on technical efficiency. In this attempt we use a cross-sectional approach.

Data used in the study are related to the university offer in academic year 2009/10, detected in 2011 by the “*Nuclei di valutazione*” of each university and collected by the CNVSU, which is a technical organism supporting Ministry activities.

The database provides comparable, complete and reliable data for all Italian universities in the sample.

The sample consists of 76 Italian universities, including 58 publicly owned and 18 private. In addition, we split the sample on the basis of the geographical location of each institution; there are 29 universities in the north, 25 in the centre and 22 in the south.

In our analysis, the basic model is the one proposed by Agasisti and Dal Bianco (2009). To take into account differences related to academic staff qualifications (Full Professors, Associate Professors, Researchers) the variable 'teaching staff' was calculated both as un-weighted sum and weighted by *punti organico*[2]. Our aim is to take into account the differences in academic staff marginal productivity. Indeed, while the staff of the first and second position, namely Full Professors and Associate Professors, has full academic obligations, the staff of the third position, that is Researches, has partial academic duties.

Table 2 describes variables used in the estimation. As we can see, we add a variable to 'First Year Enrolled students' which consider the number of students who obtained in the secondary school final exam a score higher or equal to 90/100 (ENR_M), in order to have a proxy for the students' skills.

The output variable 'Regular graduates' (REG_GRAD) is referred to those who have obtained their qualifications in terms of legal duration of the course. This variable was used as a qualitative proxy of educational output; however, it is a partial measure since it reflects only one qualitative aspect and we could have a more complete information by considering the graduate score as well[3].

The variable 'Regular students' (REG_STUD) presents differences among public and private universities (Table 3).

[2] A "punto organico" is defined as the ratio between the annual cost of a certain academic staff unit with respect to the annual cost of a Full Professor. It is 1 for Full Professors, 0.7 for Associate Professors and 0.5 for Researchers.

[3] Unfortunately, this information is not available from the data set we use.

Table 2 - Input and output variables

Variable	Description
	Input
ENR	Total number of first year enrolled students
ENR_M	Total number of first year enrolled students with a score higher than 90/100 in secondary school
REG_STUD	Total number of regular students
STUD	Total number of students including regular students
TEACH_TOT	Total number of academic staff
TEACH_TOT_ W	Weighted number of academic staff
STRUT	Total number of places available in teaching rooms, libraries and laboratories
	Output
GRAD	Total number of graduates
REG_GRAD	Total number of student graduated by the end of the legal period established to complete the degrees

Table 3 - Descriptive statistics for input and output variables

Variable	**All universities**		**Public universities**		**Private universities**	
	Media	*Dev. St.*	Media	*Dev. St.*	Media	*Dev. St.*
ENR	3.798,01	*3.617,41*	4.649,66	*3.601,99*	1.053,83	*1.944,35*
ENR_M	793,34	*809,10*	965,66	*826,41*	238,11	*412,88*
REG_STUD	11.081,25	*10.505,81*	13.517,95	*10.491,80*	3.229,67	*5.685,05*
STUD	19.023,96	*18.680,78*	23.533,83	*18.824,79*	4.492,17	*7.642,17*
TEACH_TOT	757,93	*779,96*	948,12	*784,46*	145,11	*315,38*
TEACH_TOT_ W	526,96	*539,37*	659,37	*542,76*	100,30	*207,69*
STRUT	8.141,08	*8098,64*	9.728,54	*8.190,16*	3.025,96	*5.305,32*
GRAD	2.845,22	*2.862,77*	3.464,91	*2.926,51*	848,44	*1.381,42*
REG_GRAD	590,54	*670,05*	671,91	*677,81*	328,33	*587,29*

Source: CNVSU Database

5. Estimation models

In the analysis we start from the general model applied by Agasisti and Dal Bianco (2009) which takes six inputs (ENR, ENR_M, REG_STUD, STUD, TEACH_TOT and STRUT) and two outputs (GRAD and REG_GRAD). In their work the authors, starting from this general model, verify which model is more efficient by considering the effects of the exclusion of some variables on estimates of efficiency. The final model incorporates four inputs (ENR_M, STUD, TEACH_TOT and STRUT) and two outputs (GRAD and REG_GRAD). Compared to the approach of Agasisti and Dal Bianco, in our analysis we evaluate the impact of the variable TEACH_TOT_W separately. In fact, since it is obtained by transformation of the variable TEACH_TOT, it is appropriate to treat it separately.

For the estimation we decided to use six alternative models, and in each we put some of the input variables considered (see Table 4).

Table 4 - Results

Variable	**Mod 1**	**Mod 2**	**Mod 3**	**Mod 4**	**Mod 5**	**Mod 6**
Input						
ENR	X			X	X	
ENR_M	X	X	X	X	X	X
REG_STUD	X	X		X	X	X
STUD	X	X	X	X	X	X
TEACH_TOT	X	X	X			
TEACH_TOT_ W				X	X	X
STRUT	X	X	X	X		
Output						
GRAD	X	X	X	X	X	X
REG_GRAD	X	X	X	X	X	X

In Table 5 we report the correlation indexes among variables, it shows a high correlation for the variables considered. Correlations vary between a minimum value of 0.742 with reference to the relationship between REG_GRAD and ENR_M and a maximum value of 0.996 relative to the relationship between REG_STUD and ENR. These strong correlations are not surprising, since all the variables considered capture size effects clearly related.

Table 5 – Correlation matrix

	ENR	*ENR_M*	*REG_STUD*	*STUD*	*TEACH_TOT*	*TEACH_TOT_ W*	*STRUT*	*GRAD*	*REG_GRAD*
ENR	1,000								
ENR_M	0,954	1,000							
REG_STUD	0,996	0,958	1,000						
STUD	0,977	0,958	0,987	1,000					
TEACH_TOT	0,972	0,938	0,980	0,975	1,000				
TEACH_TOT_ W	0,971	0,938	0,978	0,973	1,000	1,000			
STRUT	0,970	0,923	0,970	0,930	0,956	0,956	1,000		
GRAD	0,968	0,933	0,975	0,969	0,976	0,975	0,963	1,000	
REG_GRAD	0,822	0,742	0,814	0,746	0,792	0,791	0,878	0,833	1,000

To evaluate the most efficient model we decide to use the one with the highest consistency (more parsimony) which affects less negatively the production units. For this first estimation we use an output-oriented approach, assuming constant returns to scale. In Table 6, efficiency of each of the models considered is shown (measured in terms of average score and standard deviation), as well as correlation between them. High correlations indicates that the estimation is robust (stability of the analysis results in relation to changes in the variables considered) and highlights very similar behavior patterns. The criterion of parsimony leads us to choose between models 3 and 6. Among these, model 6 has the highest efficiency average score (67.528, while model 3 has a score of 65.220), so we assume it as the reference model.

Table 6 – Efficiency scores and correlation between models

Model	CRS		Mod 1	Mod 2	Mod 3	Mod 4	Mod 5	Mod 6
	Mean	St. Dev.						
Mod 1	66,214	20,098	1,000					
Mod 2	65,691	20,242	0,999	1,000				
Mod 3	65,220	20,244	0,995	0,998	1,000			
Mod 4	69,003	20,935	0,895	0,895	0,888	1,000		
Mod 5	68,458	21,170	0,892	0,895	0,889	0,999	1,000	
Mod 6	67,528	20,766	0,903	0,908	0,908	0,989	0,992	1,000

In Table 7 we present, for the 76 universities in the sample, efficiency scores in the hypothesis of constant returns to scale (CRS) and variable returns to scale (VRS), and the scale efficiency (scale eff). Fig. 1 shows that only a small number of universities in the sample have a very high level of efficiency, while most of them have a level of efficiency which is above 60 percent. There are, furthermore, differences regarding the method used. This may be the consequence of differences in universities dimension. Note that, regardless the sample considered, we always obtain, on average a high efficiency of scale (see last two columns of Table 8).

For readability of results in Table 7, in Table 8 are displayed some summary statistics, obtained after grouping the 76 universities by geographical area (North, Central and South) and type (Public, Private). With reference to the CRS and VRS assumptions, we note that Private Universities are more efficient than Public. This could be interpreted as a greater ability of private universities to select students more motivated, whose best results in the studies have a positive impact on efficiency levels. Moreover, with reference to geographical distribution, analysis shows that centre-northern universities are generally more efficient than southern ones.

Table 7 - Efficiency scores for Italian universities

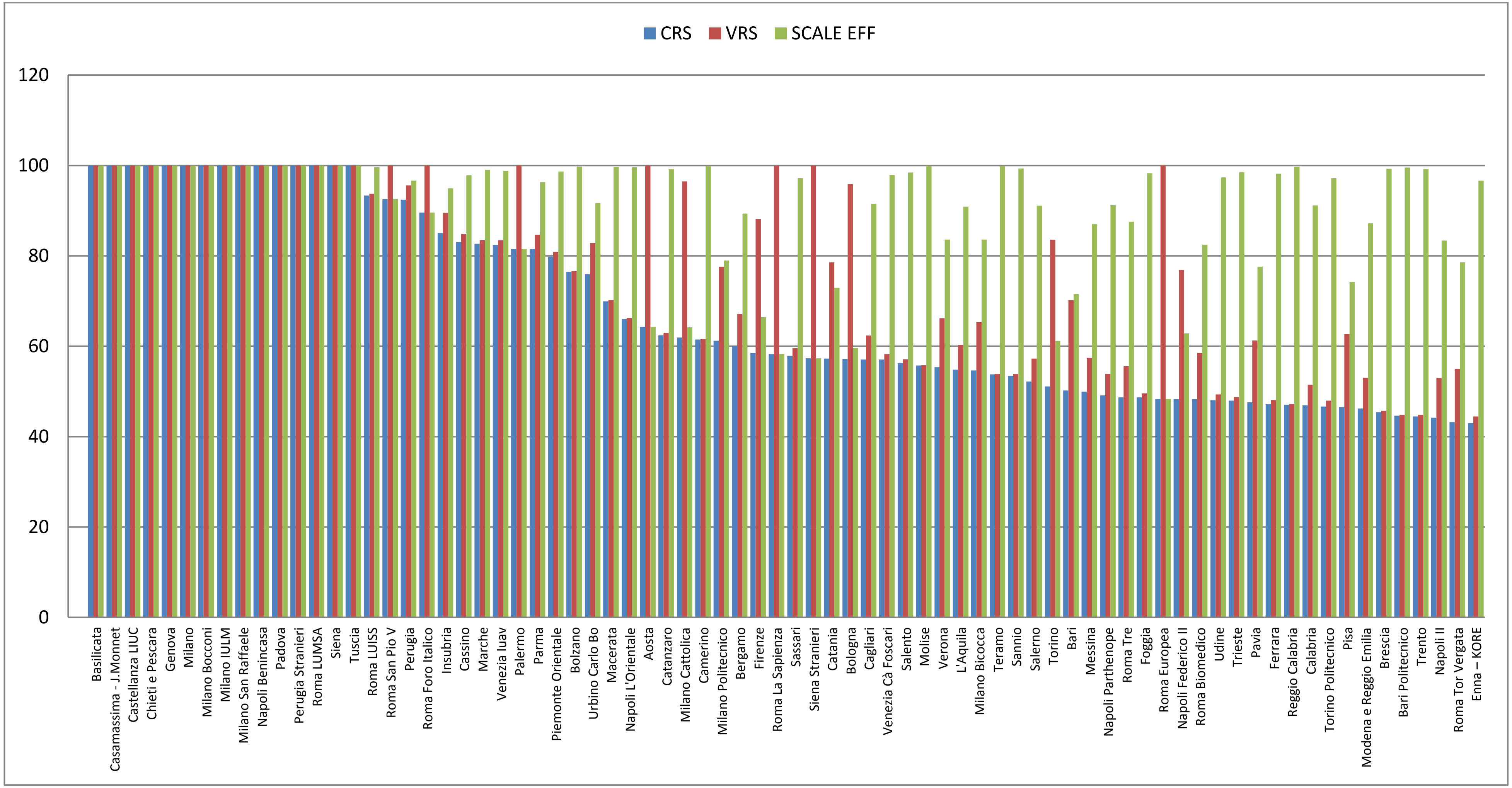
UNIT NAME	CRS	VRS	SCALE EFF
Aosta	64,28	100,00	64,28
Bari	50,21	70,17	71,55
Bari Politecnico	44,65	44,85	99,55
Basilicata	100,00	100,00	100,00
Bergamo	60,00	67,15	89,35
Bologna	57,16	95,89	59,61
Bolzano	76,50	76,67	99,78
Brescia	45,40	45,73	99,28
Cagliari	57,07	62,37	91,50
Calabria	46,93	51,49	91,14
Camerino	61,51	61,58	99,89
Casamassima - J.Monnet	100,00	100,00	100,00
Cassino	83,06	84,89	97,84
Castellanza LIUC	100,00	100,00	100,00
Catania	57,29	78,57	72,92
Catanzaro	62,44	62,97	99,16
Chieti e Pescara	100,00	100,00	100,00
Enna – KORE	42,98	44,49	96,61
Ferrara	47,21	48,09	98,17
Firenze	58,56	88,15	66,43
Foggia	48,67	49,53	98,26
Genova	100,00	100,00	100,00
Insubria	85,02	89,54	94,95
L'Aquila	54,82	60,31	90,90
Macerata	69,93	70,20	99,62
Marche	82,67	83,47	99,04
Messina	49,96	57,42	87,01
Milano	100,00	100,00	100,00
Milano Bicocca	54,66	65,39	83,59
Milano Bocconi	100,00	100,00	100,00
Milano Cattolica	61,92	96,48	64,18
Milano IULM	100,00	100,00	100,00
Milano Politecnico	61,24	77,56	78,96
Milano San Raffaele	100,00	100,00	100,00
Modena e Reggio Emilia	46,23	52,99	87,24
Molise	55,74	55,78	99,93
Napoli Benincasa	100,00	100,00	100,00
Napoli Federico II	48,30	76,86	62,84
Napoli II	44,17	52,97	83,39
Napoli L'Orientale	65,96	66,23	99,59
Napoli Parthenope	49,14	53,86	91,24

Padova	100,00	100,00	100,00
Palermo	81,51	100,00	81,51
Parma	81,50	84,65	96,28
Pavia	47,56	61,29	77,60
Perugia	92,40	95,60	96,65
Perugia Stranieri	100,00	100,00	100,00
Piemonte Orientale	79,77	80,85	98,66
Pisa	46,50	62,67	74,20
Reggio Calabria	47,04	47,19	99,68
Roma Biomedico	48,27	58,54	82,46
Roma Europea	48,36	100,00	48,36
Roma Foro Italico	89,55	100,00	89,55
Roma La Sapienza	58,27	100,00	58,27
Roma LUISS	93,34	93,73	99,58
Roma LUMSA	100,00	100,00	100,00
Roma San Pio V	92,61	100,00	92,61
Roma Tor Vergata	43,23	55,02	78,57
Roma Tre	48,68	55,61	87,54
Salento	56,21	57,09	98,46
Salerno	52,21	57,30	91,12
Sannio	53,46	53,82	99,33
Sassari	57,88	59,57	97,16
Siena	100,00	100,00	100,00
Siena Stranieri	57,33	100,00	57,33
Teramo	53,79	53,82	99,94
Torino	51,09	83,54	61,16
Torino Politecnico	46,65	47,99	97,21
Trento	44,46	44,85	99,13
Trieste	47,99	48,73	98,48
Tuscia	100,00	100,00	100,00
Udine	48,03	49,34	97,34
Urbino Carlo Bo	75,96	82,85	91,68
Venezia Cà Foscari	57,06	58,27	97,92
Venezia Iuav	82,42	83,43	98,79
Verona	55,35	66,21	83,60

Table 8 – Summary statistics

Sample	N	CRS		VRS		Scale eff.	
		Mean	*St. Dev.*	Mean	*St. Dev.*	Mean	*St. Dev.*
All sample	76	67,528	*20,766*	75,442	*20,425*	90,105	*13,369*
Public	58	63,052	*18,447*	70,064	*18,613*	90,573	*11,967*
Private	18	81,952	*21,745*	92,773	*16,190*	88,596	*17,471*
North	29	69,017	*21,292*	76,712	*20,751*	90,537	*13,269*
Centre	25	72,583	*20,918*	82,489	*18,778*	88,416	*15,708*
South	22	59,822	*18,434*	65,761	*18,797*	91,456	*10,772*

Figure 1 – Efficiency scores



6. Second stage analysis

The application of DEA in the previous section allowed us to obtain a measure of technical efficiency and showed the existence of differences among universities. This, however, is not sufficient for our purpose to investigate the reasons differences in the levels of efficiency of universities. We use a second stage analysis, by regressing DEA scores on a set of environmental variables which may influence technical efficiency.

Our model can be expressed by the following general formulation:

$$\theta_i = f(z_i) + \varepsilon_i \qquad [1]$$

where θ_i is the score of efficiency, z_i is a set of independent variables that should be related to the efficiency score of the Decision Making Unit (DMU) and ε_i is a vector of error terms.

With regard to the relevant environmental variables, we have assumed that, from a general point of view, given the small sample size, it was appropriate to estimate a parsimonious model. For this purpose, as factors that may have an impact on educational performance we consider institutional factors (public university or private), factors related to geographical location (northern, central, south) and factors related in some way, to university dropout.

With reference to the dropout, some variables in the database of CNVSU represent a proxy of the phenomenon, and allow us to evaluate indirectly the reasons for dropout. However, taking such variables as a proxy in the estimates, it is possible to evaluate the reasons for dropout[4]. In particular, data available concern the total number of inactive enrolled students (2008/09), as well as total number of inactive enrolled students in their first academic year. These two variables, being related to different cohorts of students, capture only partially overlapping phenomena. In fact, the variable relating to total entrants who have not achieved any credit captures the broader phenomenon of inactive college students, from different cohorts with different seniority of enrolment, that may be inactive in the year for heterogeneous reasons; the second variable, however, is relative to a homogeneous cohort of

[4] Analysis on dropout motivation may be found, for instance, in Gitto, Minervini and Monaco (2011).

individuals who, with high probability, will abandon or change university course (note that, in the following, both types of individuals will be considered as 'dropout').

Another factor which could have a relevant effect on universities efficiency is represented by students who attend university courses for longer than the legal duration, whose presence can impact on educational performance since take up resources of institutions. In the data set, these students are recognized as 'Not regular students'.

Table 9 displays the variables used and their meaning. In Table 10 are reported the descriptive statistics of the variables; as we can see, the 76 universities in the sample are distributed uniformly geographically (38 percent for the North, 33 percent for the Centre and 29 percent for the South), in addition, we note a predominant component (about 76 percent) of public universities.

Table 9 – Variable list

Variable	Description
VRS	*Score*s
Public	*Dummy* for Public University
North	*Dummy* for North
Centre	*Dummy* for Centre
South	*Dummy* for South
Inactive enrolled students	Students with no credit in the current year
Inactive first year enrolled students	First-time enrolled students with no credit in the current year
Not regular students	Students that should have already completed their course basing on study programme

Table 10 – Summary statistics

Variable	Mean	St. Dev.	Min	Max
VRS	75,44	20,42	44,49	100,00
Public	0,76	0,43	0,00	1,00
North	0,38	0,49	0,00	1,00
Centre	0,33	0,47	0,00	1,00
South	0,29	0,46	0,00	1,00
Inactive enrolled students	4.038,43	4.508,33	15,00	25.683,00
Inactive first year enrolled students	685,42	779,65	0,00	4.205,00
Not regular students	7.942,71	8.486,41	102,00	44.673,00

To evaluate the relationship between independent variables and, in particular, in order to verify the possibility of multicollinearity between the same variables, Table 11 shows the correlation matrix between variables. Variables (Inactive enrolled students, Inactive first year enrolled students and Not regular students) are strongly correlated with each other, therefore, multicollinearity may arise. The strong correlation between the variables indicates that variables describe similar and largely overlapping phenomena. All these variables have a positive correlation with the variable South, where these types of students are over-represented, and a negative correlation with the variable North.

Table 11 – Correlation analysis

VARIABLE	Public	North	Centre	South	Inactive enrolled students	Inactive first year enrolled students	Not regular students
Public	1,000						
North	-0,008	1,000					
Centre	-0,137	-0,550	1,000				
South	0,151	-0,501	-0,447	1,000			
Inactive enrolled students	0,457	-0,134	-0,024	0,168	1,000		
Inactive first year enrolled students	0,420	-0,117	0,005	0,120	0,940	1,000	
Not regular students	0,441	-0,134	-0,062	0,208	0,968	0,871	1,000

Estimation of the model [1] considers the distribution of efficiency scores, which are censored by construction, as a consequence, older literature have employed Tobit censored models. However, Simar and Wilson (2007) have recently argued that that this estimator may lead to inconsistent results, suggesting the use of semiparametric models. On the other hand, Hoff (2007) claimed that the OLS estimator can provide consistent estimates in the second stage analysis and McDonald (2008) shows that, while the Tobit estimator may be inappropriate, OLS provides consistent estimates. In the following we estimate the model [1] using both Tobit estimator and OLS.

Tables 12 and 13 display, respectively, the results obtained using Tobit and OLS regressions. In particular, in the analysis are considered 8 different models, depending on the variables used: Enrolled inactive, First year inactive students, Not regular students. Estimates seem to be very similar using both methods. In all the models the variable 'Public' is significant, in contrast, the variable 'Centre' seems not significant. The variable 'South' is significant, furthermore, significance increases with model complexity. Another important consideration is related to the negative sign of the variables 'South' and 'State', which might be read as an inverse link between these variables and efficiency.

Note, finally, that the presence of inactive students and dropout from studies did not significantly impacts efficiency (refer to the model (8) which has the greater degree of complexity).

Table 12 – Tobit estimates

VARIABLE	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	VRS	VRS	VRS	VRS	VRS	VRS	VRS	VRS
Constant	92.094***	92.611***	92.176***	92.024***	93.011***	91.692***	91.946***	92.164***
	(4.831)	(4.513)	(4.641)	(4.451)	(4.469)	(4.487)	(4.430)	(4.513)
Public	-20.277***	-27.688***	-25.508***	-27.857***	-27.810***	-27.450***	-27.431***	-27.584***
	(4.753)	(4.966)	(5.021)	(4.843)	(4.908)	(4.895)	(4.843)	(4.879)
South	-9.096*	-11.311**	-10.304**	-12.023**	-11.838**	-12.236**	-12.373***	-12.337***
	(4.928)	(4.652)	(4.760)	(4.614)	(4.614)	(4.623)	(4.607)	(4.607)
Centre	4.183	2.655	2.953	2.971	2.839	3.233	3.289	3.206
	(4.739)	(4.449)	(4.580)	(4.380)	(4.399)	(4.399)	(4.372)	(4.383)
Inactive enrolled students		0.002***			0.003**	-0.001		0.001
		(0.000)			(0.001)	(0.002)		(0.003)
Inactive first year enrolled students			0.007**		-0.009		-0.004	-0.006
			(0.003)		(0.007)		(0.005)	(0.008)
Not regular students				0.001***		0.001	0.001***	0.001
				(0.000)		(0.001)	(0.000)	(0.001)
Observations	76	76	76	76	76	76	76	76
Pseudo R	0.289	0.380	0.344	0.396	0.395	0.399	0.403	0.403

Table 13 – OLS estimates

VARIABLE	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	VRS	VRS	VRS	VRS	VRS	VRS	VRS	VRS
Constant	92.391***	92.878***	92.453***	92.291***	93.272***	91.977***	92.216***	92.448***
	(4.896)	(4.606)	(4.737)	(4.544)	(4.594)	(4.612)	(4.554)	(4.673)
Public	-20.668***	-28.033***	-25.875***	-28.188***	-28.151***	-27.802***	-27.772***	-27.934***
	(4.812)	(5.066)	(5.122)	(4.941)	(5.042)	(5.029)	(4.976)	(5.049)
South	-8.780*	-11.026**	-10.010**	-11.731**	-11.551**	-11.932**	-12.072**	-12.035**
	(4.995)	(4.747)	(4.858)	(4.708)	(4.742)	(4.751)	(4.735)	(4.769)
Centre	4.152	2.629	2.923	2.947	2.812	3.197	3.259	3.170
	(4.811)	(4.548)	(4.682)	(4.477)	(4.529)	(4.530)	(4.501)	(4.545)
Inactive enrolled students		0.002***			0.003**	-0.001		0.001
		(0.000)			(0.001)	(0.002)		(0.003)
Inactive first year enrolled students			0.007**		-0.009		-0.004	-0.006
			(0.003)		(0.007)		(0.005)	(0.008)
Not regular students				0.001***		0.001	0.001**	0.001
				(0.000)		(0.001)	(0.000)	(0.001)
Observations	76	76	76	76	76	76	76	76
R-squared	0.289	0.380	0.344	0.396	0.395	0.399	0.403	0.403

As a last step, we performed an analysis of robustness by estimating the model [1] only for the subsample of public universities.

In Tables 14 and 15 results of the estimates on public universities are provided. Estimates obtained are roughly similar to those described in Tables 12 and 13. This indicates a robustness of the model when applied to the subset of 58 public universities.

Table 14 – Tobit estimates on subsample of Public universities

VARIABLE	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	VRS	VRS	VRS	VRS	VRS	VRS	VRS	VRS
Constant	71.395***	62.545***	64.931***	62.122***	62.692***	62.248***	62.426***	62.438***
	(4.583)	(4.988)	(5.036)	(4.883)	(4.911)	(4.898)	(4.897)	(4.899)
South	-7.822	-11.479*	-10.070	-12.661**	-11.892*	-12.851**	-12.863**	-12.611**
	(6.720)	(6.242)	(6.448)	(6.207)	(6.148)	(6.250)	(6.197)	(6.239)
Centre	8.317	5.829	5.723	5.995	6.585	6.076	6.296	6.416
	(6.980)	(6.417)	(6.700)	(6.316)	(6.343)	(6.317)	(6.323)	(6.327)
Inactive enrolled students		0.002***			0.004**	-0.001		0.001
		(0.001)			(0.002)	(0.002)		(0.004)
Inactive first year enrolled students			0.009**		-0.010		-0.003	-0.006
			(0.004)		(0.009)		(0.006)	(0.011)
Not regular students				0.001***		0.001	0.001**	0.001
				(0.000)		(0.001)	(0.001)	(0.002)
Observations	58	58	58	58	58	58	58	58
Pseudo R-squared	0.087	0.224	0.169	0.247	0.250	0.251	0.256	0.257

Table 15 – OLS estimates on subsample of Public universities

VARIABLE	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	VRS	VRS	VRS	VRS	VRS	VRS	VRS	VRS
Constant	70.522***	64.100***	65.772***	63.484***	64.260***	63.571***	63.776***	63.858***
	(3.861)	(4.148)	(4.242)	(4.100)	(4.118)	(4.131)	(4.133)	(4.181)
South	-7.245	-9.817*	-8.828	-10.814**	-10.249*	-11.201**	-11.146**	-10.953**
	(5.672)	(5.340)	(5.500)	(5.301)	(5.310)	(5.390)	(5.339)	(5.437)
Centre	6.534	4.374	4.505	4.486	5.095	4.696	4.949	5.005
	(5.848)	(5.484)	(5.695)	(5.391)	(5.468)	(5.443)	(5.445)	(5.498)
Inactive enrolled students		0.002***			0.003**	-0.001		0.001
		(0.000)			(0.001)	(0.002)		(0.004)
Inactive first year enrolled students			0.007**		-0.010		-0.004	-0.006
			(0.003)		(0.008)		(0.005)	(0.010)
Not regular students				0.001***		0.001	0.001**	0.001
				(0.000)		(0.001)	(0.000)	(0.001)
Observations	58	58	58	58	58	58	58	58
R-squared	0.107	0.113	0.108	0.120	0.126	0.136	0.137	0.138

7. Conclusion remarks

In this paper we present an empirical analysis carried out by the DEA methodology in order to assess the levels of technical efficiency of Italian universities. The study uses data collected by CNVSU relative to the academic year 2009/10.

Differences in technical efficiency has been explained in terms of ownership (with non-state universities generally more efficient than state universities), and geographical location (with the Southern University having lowest level of efficiency).

Therefore, in order to further explore reasons for systematic differences among universities, the study was then carried out by regressing DEA scores on a set of factors which may influence technical efficiency. We use institutional factors (public university or private), factors related to geographical location and proxies of university dropout.

The analysis shows that variables related to geographical distribution and types of universities are statistically significant, so the university type 'Public' and the geographical location 'South' are connected to lower levels of efficiency. Furthermore, we find that the presence of inactive students, the number of first year inactive students and not regular students does not necessarily affect efficiency.

The results obtained from the analysis, however, although interesting, left open many questions which might be explored in future analysis.

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