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Measures for Ph.D. Evaluation: the Recruitment process

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Abstract - Recently the quality of Higher Education (HE) system and its evaluation have been key issues of the political and scientific debate on education policies all over Europe. In the wide landscape that involves the entire HE system we draw attention on the third level of its organization, i.e. the Ph.D. In particular, this paper discusses the necessity of monitoring the recruitment process of Ph.D. system because it represents a fundamental aspect of the Ph.D. system as a whole. We introduce a set of concepts related to the recruitment process and then we make them computable with synthetic indicators. The study provides an empirical analysis based on doctoral schools of four academic years at the University of Siena. Proposed indicators are finally used for detecting weakness and strength of each Ph.D. school.

Keywords: Ph.D. schools, Ph.D.s. recruitment, diversity, external attractiveness, polarization.

JEL classification: I21, I23

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1. Introduction

In the last years , the Doctorates of ”Philosophy” (Ph.D.) have gained greater importance on the European Higher Education (HE) agenda (Lisbon Agenda, 2000) because of the role of doctoral research in contributing to the growth of knowledge and innovation (Sursock and Smidt, 2010). In Italy, despite the great relevance given to doctoral studies in Europe recently, the availability and transparency of information and indicators for monitoring the Ph.D. education system as a whole is still poor and heterogeneous across universities (Ghellini *et al.* 2009). This great heterogeneity in the monitoring of such an important stage of HE results in the inability to have an objective view on the state of doctoral research in Italy (D'Agostino *et al.*, 2010). In our opinion, also at official level, the central institution (MIUR) should require to each university more detailed information about Ph.D. schools. In fact, the official evaluation process refers mainly to six criteria/indicators defined by CNVSU (D.M. n° 290 10/10/2003), which seem not to be well specified for having a complete and homogeneous assessment of the courses. For example, the sixth criterion states that each Ph.D. course has to satisfy the course objectives, also in relation to professional outlets and to the skills achieved during the Ph.D. training; such preposition presumes that each university can be able to collect information about the Ph.D. process and outcomes. However criteria/indicators referring to outcomes are often missing. In some cases, universities have a local monitoring system on Ph.D. outcomes but they are often based on *ad hoc* procedures and surveys which are non-comparable in terms of aims and contents, collection methods, questionnaires and reference times (Campostrini, 2010; D'Agostino and Ghellini, 2011; Dequarti, Gerzeli and Giudici, 2010).

In this complicated framework, we also believe that special attention have to be related to recruitment process of Ph.D.s. because this issue is

particularly neglected even if it has a determinant role in terms of level of prestige of the Ph.D. school and consequentially of the academic institution. Indeed, also in the lower level of HE the recruitment process is not properly considered as done, for example, in UK or in the United States (Aamodt, and Kyvik, 2005, Frølich and Stensaker, 2010). Aiming at this issue, the main matters to be considered are: a Ph.D. school with several applicants is attractive, a Ph.D. school that uniformly attracts students from a variety of regions has a national recognisability, a Ph.D. school that attracts students from foreign countries is internationalized, a Ph.D. school that attracts excellent students has an elevated degree of quality and again a Ph.D.'s selection strategy which does not penalize "external students" has a prominent component of openness. These are the crucial issues on which it is important to reflect in order to find appropriate indicators for measuring the Ph.D. recruitment process in Italy.

Normally the most effective recruitment programmes should be those that attract large numbers of applicants because "the more you have to choose from, the better the choice" (Herriot, 1989) but recruiting the "right" applicants could also be a higher goal. In other words, attracting and encouraging more and more candidates to apply to a Ph.D. school could be relatively easy, but the recruitment of the "right persons" takes more effort and makes a huge difference among Ph.D. schools because this means to create a talent pool of candidates that enables the selection of the best candidates for the Ph.D. school.

For the above reasons, in this study we focus on recruitment process of Ph.D.s and we analyze it on a broad theoretical and empirical basis trying to draw conclusion for improving the current assessment of Ph.D. schools. We develop our analysis in a multidimensional context by introducing several concepts that we consider essential to cover all aspects of the recruitment process and that we believe crucial in order to discriminate

among Italian Ph.D. schools. Then we put the concept into figures defining a set of indicators, and finally we define a simple measure for aggregating them in order to calculate a composite indicator useful for writing a ranking of Ph.D.schools in terms of the recruitment process. Anyway we don't give up the multidimensional context as the message that we would like to catch is an overview over all the indicators, which allows us to pick up for each Ph.D. school the relative position according to the performances of the single indicators, highlighting which are strength and weakness in each of them.

Even if the empirical analysis is based on local data relative to four academic years (from 2007/2008 to 2010/2011) of the University of Siena, the discussion can be easily generalized to a wider context and the definition of objective measures proposed in this paper should be useful for different audiences, ranging from prospective graduate students (rankings of Ph.D. schools can influence individual decisions about where to apply), to foundations and government funders, to university administrators who have to identify strength and weakness of their school.

In particular, the paper is organized as follows. In section 2, we briefly describe the different aspects that characterize the recruitment process and we introduce the concepts on which we develop our analysis. Then in section 3 we present the methodology used. In section 4 we discuss our empirical findings and in section 5 we make some final considerations.

2. Discussing on the recruitment process

2.1 Recruitment and selection phase

The recruitment process consists of two phases: the recruitment and the selection. The recruitment is the process of identifying and attracting a group of potential candidates for a particular Ph.D. school, whereas the selection involves the series of steps by which the candidates are screened in order to choose the most suitable students for the Ph.D. training.

The basic purpose of an efficient recruitment process should be to create a pool of talent applicants to enable the selection of the best candidates for the Ph.D. school, by attracting more and more students who apply, whereas the basic purpose of selection process should be to choose the right candidates for the Ph.D. training.

Generally the recruitment and selection processes are a key factor for the success of any business as they help to find the right staff (Iles and Salaman,1995) and therefore a *fortiori* they should be a crucial element in the third level of HE. Despite the great importance of the Ph.D.s. recruitment process, the assessment of Ph.D. schools in terms of its quality is seriously poor in Italy.

If the recruitment process should consist of practices and activities carried on by a Ph.D. school with the primary purpose of attracting potential Ph.D.s, the monitoring of Ph.D. process should control the recruitment and the selection policy, with the aim of ensuring, as far as possible, that the best students are recruited on merit and that the recruitment process is free from bias and discrimination. From this point of view, the first step to pursue is to introduce a set of core concepts that can be easily transformed in synthetic measures and then used for monitoring the recruitment process as a whole.

2.2. Key concepts in recruitment process

We believe that there are at least six key concepts to discuss in this framework: i) "general attractiveness", ii) "diversity", iii) "external attractiveness", iv) "quality of foreign applicants", v) "polarization" and vi) "excellence".

The importance of the concept of "general attractiveness" of each Ph.D. school is obvious.

Generally, the meaning of "diversity" in HE refers to the broader concept of ethnic diversity (American Psychological Association Office of Ethnic Minority Affairs, 2000; Gurin *et al.*, 2002); in this framework we

adapt the concept and we use the word with a restricted meaning[2]. Indeed for us "diversity" means to have heterogeneity among applicants in terms of universities where applicants have taken their graduation.

Nowadays, internationalization is wide recognized as one of the most important aspects in HE (IAU, 2003) as it constitutes a desirable form of academic diversity. In a wider picture, whatever strategy of a Ph.D. school which inclines to increase external students (i.e. foreigners or applicants coming from other Italian universities) has a prominent component of openness. In this view, we refer to "external attractiveness". Substantially, it is necessary to qualify diversity by measuring if it is directed towards a "Siena exclusive" shape or, on the contrary, towards completely internationalized shape**.**

Following this perspective, another key issue to face is related to the presence of foreign students. That is, it's not altogether true that quantity means quality. Indeed, it is well known that the variability in HE around the world is wide; for example, education in developing countries cannot be compared with well-organized educational systems like in Europe. However it is also true that it is better to rank universities than countries. In fact, in the world wide university ranking there are also Chinese and Indonesian universities in the top 200 (Universities Web Ranking, http://www.4icu.org/top200). However, whatever classification is adopted, the crucial aspect to take into account is the reputation of the foreigners' applications. In that way we refer to "quality of foreign applicants"[3].

The other important concept that is necessary to clarify is what we call "polarization". As explained above, medium/high degrees of diversity can also be due to an elevated presence of applicants coming from other

[2] In other frameworks of HE, the term diversity is also used with regard to variety among programs or services by academic institutions (Rossi, 2009; Teixeira *et al.*, 2011).
[3] Unfortunately, in empirical data we used, the name of the origin university of applicants is unknown or bad reported; therefore the country of origin has to be taken into account necessarily.

Italian universities. Instead of counting such universities (i.e. the richness in general) we believe that it is more important to measure if there is a particular base that polarizes. In brief, the higher the polarization level of Ph.D. schools, the lower will be their diversification in terms of applicants.

Finally, the recruitment of excellent students who are highly motivated and qualified for the Ph.D. training has to be another of the priorities of schools as the quality of students that a school is able to attract increases its value. Substantially it would be important to measure the "excellence" by the proportion of applicants graduated with a full mark.

Unfortunately, this concept can have some problems when it has to be translated in an objective indicator due to available data. Indeed, in several academic institutions, included the university of Siena, foreign applicants report their maximum degree mark in a not comparable way with the Italian degree with laude. Moreover it is also well-known that in Italy there is a high degree of heterogeneity among different educational fields (for example, some of them have a greater propensity to give higher marks than others) and controlling for this presumable bias effect needs further information[4].

3. Methodological framework

The methodological framework is multifaceted, first because several concepts introduced in previous section have to be translated into synthetic measures; secondly because a formula for aggregating single indicators has to be defined. In order to simplify matters, we present the methodological framework divided into two basic perspectives previously mentioned: the attractiveness and the selection process. In particular, we pay more attention on the former as available data do not allow to deeply discuss the latter. Finally we define the composite indicator for aggregating single indicators.

[4] In our empirical analysis we do not consider this aspect as we check several deficiencies in data.

3.1. Measuring attractiveness

The general evaluation question is: is the Ph.D. school attractive? In order to establish if a Ph.D. school can be considered attractive we need to evaluate quantitatively and qualitatively its applicants.

Employing this perspective entails a preliminary examination of two population, on which indicators have to be referred: the applicants and the population of maintaining applicant status. Practically, we deal with the maintaining applicant status as they are the real population attending the selection; to simplify the reading, from now, we use the label of "applicants" for the population attending the selection.

A measure for quantifying attractiveness

For quantifying applicants we wonder: how many students compete for a grant? The simple index that we need to compute to answer this question is the ratio between the number of applicants and the number of available grants. Indeed this indicator counts how many applicants we have for each grant. It only takes positive values and it does not have a maximum, so we prefer to normalize it as follows:

$$IA_{ij} = \frac{\frac{nA_{ij}}{nG_{ij}} - \min_i \left(\frac{nA_{ij}}{nG_{ij}} \right)}{\max_i \left(\frac{nA_{ij}}{nG_{ij}} \right) - \min_i \left(\frac{nA_{ij}}{nG_{ij}} \right)} \quad (1)$$

where nA_{ij} is the number of applicants and nG_{ij} is the number of available grants in the *i-th* (*i=1…I*) Ph.D. school belonging to the *j-th* (*j=1…J*) educational field. Now the IA index may take values in the range [0,1] and indicates whether a school is the least attractive (i.e. it assumes minimum value equal to 0 for the least attractive school, the one presenting the smallest ratio $\frac{nA_{ij}}{nG_{ij}}$) or it is the best attractive school (the one presenting the largest ratio $\frac{nA_{ij}}{nG_{ij}}$).

Measures for qualifying attractiveness

For qualifying attractiveness several features can be considered. "Diversity" is the first of them. This concept relates to the evaluation question: where do applicants achieve their graduation?

In order to make this concept computable with a synthetic indicator we aggregate the information about the provenance of applicants, by using the categorical variable *Y*, whose categories are: a) University of Siena, b) other Italian university, c) foreign university[5].

In social science, an index of diversity also referred to heterogeneity is a commonly used measure to determine variation in categorical data (Leti 1983, pag. 266). As the number of categories increases, the maximum value of such index also increases; therefore a relative diversity index is adopted and it is defined as:

$$ID_{ij} = \left(1 - \sum_{k=1}^{K} p_{ijk}^2\right) \frac{K}{K-1} \qquad (2)$$

where k=1…K=<3 is the number of categories of *Y*, and p_{ijk} is the proportion of applicants in the *k-th* category of Ph.D. school *i* in educational field j.

ID indicator takes values in the range [0,1]. Low values imply that the Ph.D. school *i* is more concentrated (the minimum value 0 is reached if and only if applicants are perfectly homogeneous, that is all of them belong to the same category of *Y*) whereas higher values mean that the school is more diversificated (*ID* assumes maximum value equal to 1 for schools whose applicants are perfectly heterogeneous, that is they are equally distributed among the categories of the *Y* variable).

"External attractiveness" is the second feature. In order to introduce the corresponding indicator related to this concept we start from the

[5] An interesting widening of categories could be to consider applicants coming from association among universities, but empirical data do not have this information.

consideration that we could have *ID*=0 even if all the applicants belong to the category "c) foreign university", that is certainly unusual, but should be desirable in terms of internationalization of the Ph.D. school *i*. In this perspective, the evaluation question is: which is the degree of unlikeness of the observed distribution of applicants from the optimal theoretical distribution for a full internationalization of the Ph.D. school *i*?

So that we assume that categories of variable *Y* have an ordinal sense as follows: "University of Siena", "other Italian university", "foreign university". The internalization index which can be viewed as an unlikeness index (Capursi and Librizzi, 2008) is defined as:

$$IE_{ij} = 1 - \sqrt{\frac{1}{K-1}\sum_{k=1}^{K-1} P_{ijk}^2} \qquad (3)$$

where P_{ijk} is the cumulative proportion of applicants in the category *k (k=1…K<=3)* of school *i* in educational field *j*.

IE index takes values in the range [0,1]. A Ph.D. school "Siena exclusive" will have an unlikeness score of 0, the index increases if the degree of "openess" increases and for a Ph.D. school completely internationalized we will have an unlikeness score of 1**.**

"Polarization" is the third feature. Substantially we intend to evaluate if there is a sort of polarization of a particular Italian university[6] in the category "other Italian university". In this context the evaluation question is: is there a particular Italian university (only among other universities), from which the main part of the applicants of a given Ph.D. school applies?

To capture this concept we define the following indicator:

$$\begin{cases} IP_{ij} = \left(1/\max\left(p_{ij}^{out}\right)\right)/\left(1/L_{ij}\right) & \text{if } L_{ij} > 1 \\ IP_{ij} = 0 & \text{if } L_{ij} = 1 \end{cases} \qquad (4)$$

[6] The phenomenon of polarization should be relevant if a PhD school is founded on an association among universities.

where p_{ij}^{out} is the proportion of applicants that apply from "other Italian universities" ($l=1\ldots L_{ij}$) of Ph.D. school *i* in educational field *j*.

This index takes values in the range [0,1]. A Ph.D. school with the maximum degree of polarization assumes an index score of 0, while a Ph.D. school with the minimum degree of polarization assumes an index score of 1. When there is only one Italian university except Siena that competes in a Ph.D. (i.e. L_{ij} =1), we force the index to assume a zero value, assuming a maximum degree of polarization[7].

Finally, "quality of foreign applicants" is the forth feature. Substantially, we move our attention to the subset of applicants belonging to the category "foreign applicants". As we explained in previous section, it is important for a Ph.D. school to take into account the prestige of the universities from which applicants come from. Of course it is a very difficult task, because this implies to have a perfect coding of the variable containing the name of the degree university for each applicant. In order to bypass this problem we use as proxy of the prestige of the university, a measure of "the prestige" of the country to which the university belongs; particularly we refer to the Human Development Index (HDI)[8]. So that we define the "quality of foreign applicants" index as:

$$I\_HDI_{ij} = \frac{nF_{ij}^{VH}}{nF_{ij}} \qquad (5)$$

[7] Actually, in order to understand if there is a real high level of polarization, that index should be evaluated jointly to IE, because we certainly cannot assert that there is a serious problem of polarization if there is just one applicant coming from "other Italian university" and all the others coming from the "University of Siena" or from "foreign university".

8 The Human Development Index (HDI) is a summary measure of development which combines information on life expectancy, schooling and income. Many countries with a Very High HDI are also OECD members but there are some exceptions: Chile, Mexico and Turkey are members of the OECD but have not a Very High HDI, while Liechtenstein, Singapore, Barbados, Qatar, Brunei Darussalam, Cyprus, Estonia, Malta, United Arab Emirates and Hong Kong, China (SAR) are outside of the OECD but are considered developed countries according to the Human Development Index (HDI) - 2010 Rankings.

where $\frac{nF_{ij}^{VH}}{nF_{ij}}$ is simply the proportion of applicants coming from foreign universities belonging to a country with "very high" level of *HDI*.

I_HDI index takes values in the range [0,1]. A Ph.D. school will be better than others in terms of "quality of foreign applicants" if it assumes values close to 1.

3.2 Measuring the selection process

The measurement of the selection process is for sure a very hard task. The selection should guarantee to choose the most suitable candidates by using the most appropriate, efficient, fair, open and effective methods.

As a preliminary attempt to propose a measure for the assessment of the selection process we decided to compute the indexes ID_{ij} and IE_{ij} already calculated for the population of applicants, also for the population of winners. The basic idea is: if we assume that diversity is one of the most important aim of the recruitment strategy, we can affirm that the optimal sharing of the available grants of each Ph.D. school would be similar to the observed distribution of applicants. Obviously, observing the values of the indexes computed for the winners, we need to take into account of the values that the corresponding indexes assume for the applicants, population that we can consider as our conditioning distribution.

The development of more suitable indicators for measuring the selection process is obviously one of our aims but available data for the empirical analysis allow us to calculate only the indicators mentioned above that are strongly correlated with the corresponding indicators calculated on the population of the applicants.

3.3. Definition of the composite indicator

The literature of composite indicators offers several examples of aggregation techniques (Saisana *et al.*,) as the construction of a composite indicator is not straightforward and the methodological challenges raise a

series of technical issues that, if not considered adequately, can lead to composite indicators being misinterpreted. Anyway at official level, in empirical analysis, the most developed formula is the simplest additive aggregation method that entails the simple average of sub-indicators having the same measurement unit. Let I_{ijs} *(s=1…S)* be the *s-th* sub-indicator for the school *i* in the educational field *j*; we define the composite indicator as:

$$I_{ij}^{comp} = \sum_{s=1}^{S} I_{ijs} / S \qquad (6)$$

4 Empirical analysis

4.1. Descriptive statistics

The University of Siena sets up each year a number of Doctoral Schools belonging to four scientific fields defined as in Table 1. The admission requirements for each school are specified in the relevant regulations for participation and are described in detail on the university web site (http://www.unisi.it/internet/home.html); in general, almost all the schools select candidates considering their curricula and an interview. The empirical analysis refers to four academic years from 2007/2008 to 2010/2011 and it is based on administrative data (SIDRO archive). As shown in the Table 1, the number of Ph.D. courses have not a substantial variation across specialties and it remains also stable across academic years. It should be noted that for the interdisciplinary area (originated from the union of the areas C and A) there is only one Ph.D. school; for this reason in the following analysis we merge this area with Experimental Sciences (area A).

As regard to the number of Ph.D. courses offered, the University of Siena shows a different trend, with respect to the National landscape as reported in the XI report CNVSU (CNVSU, 2011). In fact, while at national level between 2007/08 and 2009/2010 a decreasing trend can be observed,

in Table 1, it can be observed a slight increasing in the number of Ph.D. courses offered by the University of Siena.

Table 1. Ph.D. Courses by scientific field and academic year, University of Siena

Scientific field	Academic year			
	2007/08	2008/09	2009/10	2010/11
A. Experimental Science	8	9	9	9
B. Biomedical and Medical Sciences	8	9	9	9
C. Literature, History, Philosophy and Arts	6	6	7	7
D. Economics, Law and Political Science	8	7	7	7
I. Interdisciplinary Area (Areas C and A)	1	1	1	1
Total	31	32	33	33

Table 2. Number of applicants (n) and %, by geographic area, a.y. 2007/08-2010/11, University of Siena

	Academic years							
Country	2007/08		2008/09		2009/10		2010/11	
	n	%	n	%	n	%	n	%
EU (27 countries) - Italy	46	3.78	27	2.15	60	4.42	48	4.04
Europe-extra EU	22	1.81	21	1.67	27	1.99	17	1.43
South America	12	0.99	13	1.04	14	1.03	6	0.50
Asia	29	2.38	41	3.26	77	5.67	54	4.54
Africa	21	1.73	26	2.07	31	2.28	12	1.01
North America	11	0.90	11	0.88	10	0.74	5	0.42
Oceania	-	-	2	0.16	3	0.22	-	-
Italy	1075	88.40	1115	88.77	1136	83.65	1047	88.06
Total		100		100		100		100

As regard to the percentage of the enrolled units who have achieved the degree title in a foreign university, the percentage is significantly higher with respect to the national figures provided in CNVSU 2011 report, already mentioned above; in fact the national figures show a mild but continuous increasing between the 3.2% (2003/04) to 8% (2009/10), while as shown in Table 2, the percentage of the enrolled units who have achieved the degree title in a foreign university is around the 12% and even greater (around 14%) in 2009/10. However, the negative evidence, with respect to the national landscape is that in Siena the general trend is uniform and not

increasing. It is positive to note, observing Table 3, that the group of the enrolled units who have achieved the degree title in a foreign university is mainly composed by students coming from countries with a very high or high HDI for all the Academic years.

Table 3. Number of applicants (n) and % by HDI, a.y. 2007/08-2010/11, University of Siena

	Academic years							
HDI	2007/08		2008/09		2009/10		2010/11	
	n	%	n	%	n	%	n	%
Very high	52	4.28	41	3.26	69	5.08	59	4.96
High	51	4.19	50	3.98	58	4.27	40	3.36
Medium	29	2.38	39	3.11	68	5.01	35	2.94
Low	9	0.74	11	0.88	27	1.99	8	0.67
Italy	1075	88.40	1115	88.77	1136	83.65	1047	88.06

Evidences coming from Figure 1 seem to be very interesting. Observing figures related to the number of advertised grants, it is evident that the declining trend reflects the one related to the courses supply at national level (CNVSU, 2011), with the strongest declining in a.y. 2009/10. It is curious to observe that on the side of the demand the feeling of the economical crisis has been perceived one year later: the decrease in the number of applicants and participants has started in a.y. 2010/11.

Figure 1. University of Siena a.y. 2007/08-2010/11: number of grants, applicants, participants at the selection

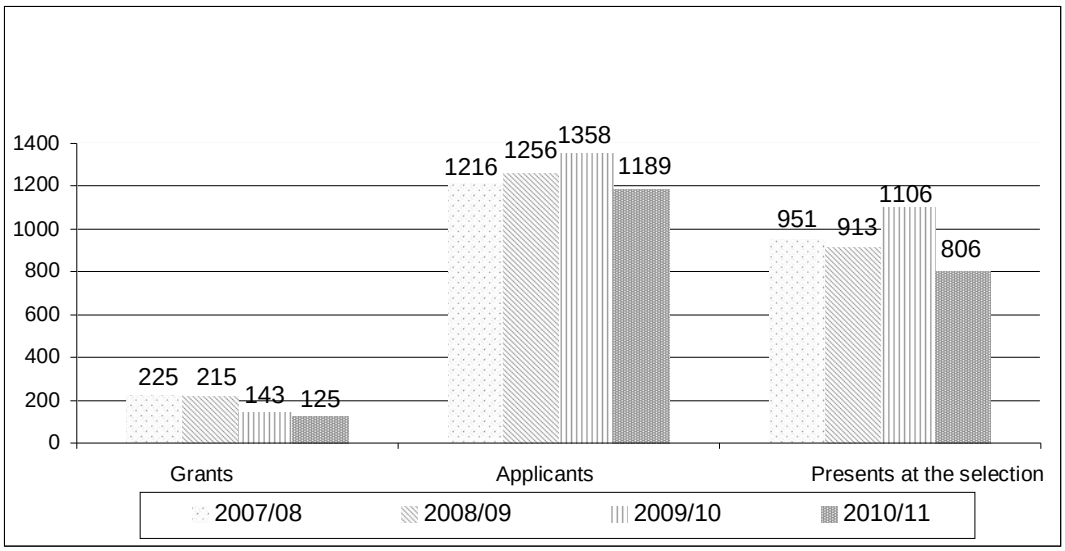
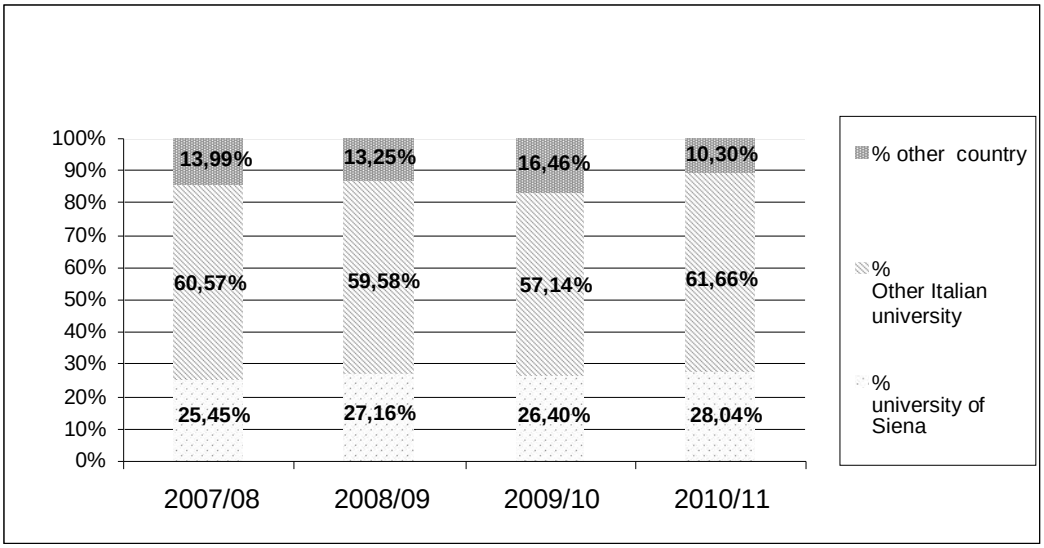


Figure 2. University of Siena a.y. 2007/08-2010/11: composition of the participants at the selection (percentages)



4.2. Assessment of Ph.D. schools in terms of recruitment process

In order to have an adequate number of observations in each Ph.D. school, especially for the population of winners, we pooled data across years. We find that in 95% of Ph.D. schools the number of maintaining the

applicant status is lower than the amount of applicants and this kind of selection causes less diversity because the external applications decrease. Moreover, there are no significant differences among educational fields (see Table 4).

As explained in section 3, the single indicators presented refer effectively to the population of maintaining applicant status as this group represents the students that really compete for the selection.

Table 4. University of Siena – pooling data: number of applicants, maintaining applicant status, winners, grants by educational field

Educational field[9]	Applicants	Maintaining applicant status	Winners	Grants	# Ph.D. schools
A & I	1059	881	360	215	11
B	917	676	316	203	9
C	1644	1229	275	152	7
D	1399	990	218	138	10
Total	5019	3776	1169	708	37

Using the concepts and the indicators introduced in the previous sections, we characterize Ph.D. schools in terms of scores of the composite indicator and the patterns of the single indicators.

As preliminary analysis we compare the mean value and the coefficient of variation (c.v.), disaggregated by educational fields of each single indicator (see Table 5). For a quantitative assessment of attractiveness the *IA* index is considered. The index highlights a significant difference between the average values obtained by the C and D educational fields and the ones obtained by A and B[10]. This heterogeneous behavior among areas justifies the large value of the c.v. computed for the whole set of Ph.D.

[9] In the interdisciplinary area (I) there is only one Ph.D. school; therefore we merge this area with Experimental Sciences.

[10] Substantially, if we refer to the quantitative index counting the number of applicants per grant, we could assert that on average, the Ph.D. schools belonging to the scientific field C and D have about 8 applicants for grant, while the Ph.D. schools belonging to the scientific field A and B have about 4 applicants for grant.

schools. Moreover, it is worth to note that the D area, the one presenting the largest average value for *IA*, is also characterized by a very high c.v. value.

For a qualitative assessment of attractiveness the other indexes reported in Table 5 are considered. Let us begin with the *ID* and *IE* couple. The *ID* index is in general rather high (the average on the whole is 0.70) and it means that there is a significant degree of diversity. The educational field presenting the smallest *ID* index is C, however it is the one presenting the largest *IS* value, so it is the most open to applicants coming from foreign universities; on the other side we have the B field which is the most heterogeneous and consequentially the less internationalized.

As regard to the *IP* index, the A, B and D educational fields present similar values while C presents the lower value. If we consider this last result jointly with the over-mentioned, we have that the C area is, on average: very attractive, less diversified than the others but the high variability of *ID* index causes an external attractiveness level similar to D area. Finally it seems to suffer of high polarization.

Looking at *I_HDI* index, its values are significantly greater for A and C educational fields, whereas for B and D areas we find lower levels of *I_HDI* but a very high variability. After all, in order to make some conclusion on the selection process we compare the *ID* and *IE* index computed on the population of applicants with those calculated on the population of winners (i.e. *ID_w* and *IE_w* indices). The distribution of the winners, on average, seems to reflect the one of the applicants for the A and B educational fields; the larger positive difference between the two distributions is recorded for the D area, even if we have a very good result for this area as regard to the IE indexes; in fact, on average, the distribution of the winners reflects the one of the applicants. For the other educational fields, the difference between *IE* and *IE_w* is always positive, meaning that on average the selection process inclines to reduce diversity towards Siena exclusive shape.

Table 5. Mean and c.v. of single indicators by educational fields

	Educational field									
	A		B		C		D		Total	
Indicator	mean	c.v.	mean	c.v.	mean	c.v.	mean	c.v.	mean	c.v.
IA	0.13	0.93	0.09	1.17	0.31	0.52	0.32	0.90	0.21	0.99
ID	0.77	0.28	0.79	0.13	0.49	0.37	0.69	0.16	0.70	0.27
IE	0.44	0.24	0.30	0.33	0.53	0.21	0.50	0.35	0.44	0.33
IP	0.31	0.41	0.41	0.31	0.20	0.43	0.34	0.35	0.32	0.41
I_HDI	0.38	0.82	0.22	1.48	0.37	0.67	0.32	1.05	0.32	0.93
ID-w	0.72	0.17	0.75	0.13	0.60	0.40	0.57	0.44	0.66	0.29
IE-w	0.33	0.39	0.24	0.29	0.48	0.33	0.50	0.44	0.38	0.48

The effective assessment of the recruitment process of the Ph.D. schools is presented in Table 6. The ranking is based on the composite indicator defined in equation (6). This indicator, however does not take into account all the aspects previously mentioned but only the first four indicators: *IA*, *ID*, *IE*, *IP*. The *I_HDI* index is neglected because for some Ph.D. schools the number of foreign applicants is actually very low. The other two indicators, based on the population of winners, are neglected as they are heavy correlated with the respective indicators calculated on the applicants.

Accordingly, in Table 6 thirty-one schools are listed[11]. They are sorted by their score on the composite indicator, reported in the last column. We decided not to report the scores of each indicator for each school, because, even if the quantitative figure are surely much more informative, it results harder to succeed in having an overall view of the performance of a Ph.D. school with respect to the others. Therefore we prefer to report the performance obtained as regard to each indicator *I* using the classification scheme illustrated in Table 7.

We begin with general observations that can be seen from a cursory inspection of the ranking. At the top, the D and A education fields dominate

[11] We included in the final ranking all Ph.D. schools for those we had information at least for three years.

followed by B area, whereas at the bottom we find mainly schools of B and C area and also some schools of A educational field.

Particularly, the two best schools belong to D "Economics, Law and Political Science" and the following two to A "Experimental Science". Substantially, in this top position the schools of D area are characterized by the following pictures: quite high general attractiveness, medium level of diversity, very high degree of external attractiveness and poor level of polarization. At the same time they attract foreign students of good quality (see *I_HDI* indicator). The first school is also able to correct the distribution of applicants toward very high level of diversity and internationalization by the selection process. The two schools of A education field show poor performances in terms of attractiveness but take advantage from a higher diversity, basically due to a high presence of applicants coming from other Italian universities and, among them, we do not discover a polarizing academic institution.

Anyway in the first eleven positions we also find three schools of B area whose performances indicate a general lower capacity to attract, with respect to the D education field; they present a positive performance as regard to the diversity index (*ID*), and a negative performance regarding to the external attractiveness. However these schools are collocated in the top piece of the table thanks to good performance in the *IP* indicator.

In the middle of the ranking we find especially schools in C "Literature, History, Philosophy and Arts" educational field. They have, on average, good performances in terms of *IA* index but a poor level of diversity as they tend to a high degree of internationalization. Moreover they also have very poor performances in terms of polarization.

Table 6. Ranking of Ph.D. schools based on the recruitment phase, University of Siena – pooling data

				Indicators							
				Participants					Winners		
Ph.D. schools	n*	n**	Educational field	*IA*	*ID*	*IE*	*IP*	*I_HDI*	*ID_w*	*IE_w*	I^{comp}
23	177	28	D	+	+	+ +	-	+	+ +	+ +	0.53
9	314	38	D	+	0	+ +	-	0	0	+ +	0.53
33	29	12	A	-	+ +	+	+ +	-	0	0	0.51
24	106	49	A	-	+ +	0	+ +	- -	+	-	0.50
8	63	29	D	-	+	+	+	-	+	-	0.49
28	135	33	A	+	+ +	0	-	0	+	-	0.46
32	40	21	B	-	+	-	+ +	- -	+	-	0.46
4	45	37	B	-	+ +	-	+	0	+ +	0	0.45
34	113	20	A	+ +	0	0	-	+	+	-	0.45
12	69	25	B	-	+	-	+ +	-	+	-	0.44
2	54	27	A	-	+	-	+	+ +	+ +	-	0.43
19	182	36	B	+	0	+	- -	-	+	-	0.43
20	118	25	C	+	0	0	- -	0	+ +	0	0.43
5	138	65	B	-	+ +	-	0	-	+	-	0.41
14	114	50	A	-	+ +	-	- -	+	+	-	0.40
7	196	52	D	0	0	+	- -	-	- -	+	0.40
18	47	31	B	-	+	-	+ +	- -	+	-	0.40
16	373	71	C	+	-	+	- -	0	0	0	0.39
17	242	53	C	+	-	+	- -	-	+	0	0.39
21	162	48	C	0	-	0	-	+	+	-	0.39
15	44	19	D	-	-	0	+		0	0	0.38
6	46	21	D	-	-	- -	+ +	- -	-	- -	0.37
27	124	53	A	-	0	-	-	0	+	-	0.37
26	55	45	A	-	+	- -	+	- -	+	-	0.36
25	58	33	B	-	+	- -	0	- -	0	- -	0.36
30	41	26	A	-	- -	+ +	-	+ +	-	+ +	0.34
1	45	28	B	-	0	- -	+	- -	-	- -	0.34
3	52	40	B	- -	0	- -	+ +	+ +	0	- -	0.33
10	36	18	C	-	- -	+ +	+	+	- -	+ +	0.33
22	210	53	C	+	- -	+	- -	+ +	-	+	0.32
11	67	28	A	-	- -	+ +	- -	0	- -	+	0.31

* n refers to the population of applicants, ** n refers to the population of winners

At the bottom of the ranking we find a mixture of Ph.D. schools belonging to different educational fields; indeed several of them show poor attractiveness and some others poor diversity and high polarization. Taking, for example, the two bottom PhD schools, their external attractiveness performance is good but they heavy suffer of polarization.

Table 7. Classification system used for defining single index performance

Intervals	Classification	Index Performance
$I \le (\bar{x} - s)$	Very poor performance	"- -"
$\bar{x} - s < I \le \bar{x} - 0.25s$	Poor performance	"- "
$\bar{x} - 0.25s < I < \bar{x} + 0.25s$	On average	" 0 "
$\bar{x} + 0.25s \le I < \bar{x} + s$	Good performance	"+ "
$I \ge (\bar{x} + s)$	Very good performance	" ++"

5. Some final remarks

The ranking exercise has become more and more common in recent years despite the widespread criticism of which factors have to be measured and the way measurements are carried out. The main purpose of the use of rankings in higher education institutions -university, faculty, department- should be to make complex circumstances more transparent, especially for students who have to choose in an aware way. We also stress that, in Italy, the evaluation of the performance and the following ranking would be very important for the highest educational level, i.e. the Ph.D. where central institution should invest money in an efficient way in order to contribute to the growth of knowledge and innovation.

We believe that a proper monitoring and evaluation process should start from the recruitment phase as it represents the input for the overall Ph.D. process, however this aspect is always neglected in the official report that universities have to present at the end of each academic year.

In this view, we propose a final ranking of Ph.D. schools using several aspects of Ph.D. recruitment process. Indeed, the final important result of this paper is not the final ranking, but it is the possibility of highlighting strength and weakness in each Ph.D. school for aspects concerning the recruitment process. This information, if properly used, with other information can improve the assessment of each Ph.D. school and in

the long term can help to operate a right rationalization of resources by improving the existing Ph.D. schools in their deficiencies and by decreasing the number of those having several shortages.

As final remark, we add that this paper is intended, not simply to report on the current picture, but also to discuss an agenda for presenting actions and future changes. The present, in this case could be our enemy. The debate on the present could be our challenge.

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