

MEASURES FOR PH.D. EVALUATION: THE RECRUITMENT PROCESS¹

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Abstract: *In the last years 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.*

Key words: *Ph.D. schools, Ph.D.s. recruitment, diversity, external attractiveness, polarization.*

1. Introduction

In the last years, the Doctorates of "Philosophy" (Ph.D.) has 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 the 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 often they are 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 the recruitment process, 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 an national appreciation, 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 mean 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 allow us to pick up for each Ph.D. school the relative position according to the performances of the single indicators, highlighting which are the strength and the 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 funds, to university administrators identifying 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 report 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 is closely linked to the credit that the Ph.D. school has on the market: if a particular Ph.D. school of a peculiar educational field is able to attract many applicants with respect with the numbers of grants offered, it probably has a greater recognition than another Ph.D. school with less number of applicants in the same educational field. Of course, this is a quantitative way of measuring attractiveness that certainly is not the only way to measure this concept. Indeed, the attractiveness could be also measured using a qualitative assessment, based on information collected from applicants through ad-hoc interviews.

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). There could be other interesting approaches to consider the diversity, for example, from gender, age, religion viewpoint and moreover, 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). However, in this framework, we adopt the concept of diversity with a restricted meaning: 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 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 “local 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 applicants².

The other important concept that is necessary to clarify is what we call polarization. Medium/high degrees of diversity in a Ph.D. school of a particular local institution can be due to an elevated presence of students that apply from the other Italian universities. Instead of counting the richness (i.e. how many other Italian universities compete in each Ph.D. school of this particular local institution), we believe that it is more important to measure if there is a particular base (among other universities) 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, and also in 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 information³.

3. Methodological framework

The methodological framework is multifaceted because the several concepts introduced in previous section have to be translated into synthetic measures. 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.

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 the 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, in a given academic year, we wonder: how many students compete for a grant? The index that we could compute to answer that question is simply 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 $[0,1]$: it assumes minimum value equal to 0 for the less attractive school (the one presenting the smallest ratio $\frac{nA_{ij}}{nG_{ij}}$) and it assume the maximum value for the

best attractive school (the one presenting the largest ratio $\frac{nA_{ij}}{nG_{ij}}$). The values within the range

$(0,1)$ indicates the relative position of the generic Ph.D. school in the ranking, with respect to the worst or the best Ph.D. school.

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: Do the applicants achieve their graduation in different places?

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 university⁴.

In social science, an index of diversity also referred to heterogeneity Gini index 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:

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

where $k=1 \dots K < 3$ 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 the Y) whereas higher values mean that the school is more heterogeneous (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 consideration that we could have $ID=0$ even if all the applicants belong to the category "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:

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

where P_{ijk} is the cumulative proportion of applicants in the category k ($k=1 \dots K <= 3$) of school i in educational field j . IE index takes values in the range $[0,1]$. A Ph.D. school "local (Siena) exclusive" will have an unlikeness score of 0, the index increases if the degree of "openness" increases and for a Ph.D. school completely internationalized we will have an unlikeness score of 1.

Polarization is the third feature. Now, for each Ph.D. school we consider only applicants belonging to the category "other Italian university". Therefore let p_{ijl}^{out} be the proportion of students of the Ph.D. school i in educational field j that apply from the l -th ($l=1 \dots L_{ij}$) other Italian university. Substantially we intend to evaluate if, for a given Ph.D. school, there is a preponderance (polarization) of applicants from a particular university over the "other Italian universities". In that 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:

$$\begin{cases} IP_{ij} = 1 / \left[\max_{l=1 \dots L_{ij}} (p_{ijl}^{out}) / (1 / L_{ij}) \right] & \text{if } L_{ij} > 1 \\ IP_{ij} = 0 & \text{if } L_{ij} = 1 \end{cases} \quad (4)$$

This index takes values in the range [0,1]. A Ph.D. school with the minimum degree of polarization assumes an index score of 1 (proportion equally distributed among universities), the index decreases with the increasing of polarization and we force the index to assume a zero value, for a maximum degree of polarization⁵.

Finally, *quality of foreign applicants* is the fourth 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 that 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)⁶. So that we introduce a simple ratio that we label as "quality of foreign applicants" index as:

$$I_HDI_{ij} = \frac{nF_{ij}^{VH}}{nF_{ij}} \quad (5)$$

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*. Obviously the *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.

3.1. 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.

3.2. Definition of the composite indicator

The several indicators defined in the previous sections make difficult to draw up a single ranking of the Ph.D. schools. For this reason, we introduce a composite indicator, on which a "crude" ranking of the Ph.D. schools can be written. The literature of composite

indicators offers several examples of aggregation techniques (Saisana *et al.*, 2005), anyway, the definition 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 (Pele, 2009). At official level, in empirical analysis, the most adopted formula is the simplest additive aggregation method that entails the simple average of sub-indicators having the same measurement unit, therefore we follow this methodology.

In detail, let I_{ijs} ($s=1\dots S$) be the s -th sub-indicator for the school i in the educational field j ; we define the composite indicator as:

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

However, in the empirical analysis, equation (6) does not take into account all the indicators 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.

However, we are aware that equation (6) may be subject to criticism for its simplicity, but in this framework the definition of the composite indicator is not our aim. Indeed, we use the composite indicator in order to support a "rule" by which to classify Ph.D. schools without losing sight of the multidimensional nature of phenomenon studied. This last aspect will be clarify in the empirical analysis.

4. Empirical analysis

4.1. Some general figures

The University of Siena sets up each year a number of Doctoral Schools belonging to the following five educational fields: Experimental Science (A), Biomedical and Medical Sciences (B), Literature, History, Philosophy and Arts (C), Economics, Law and Political Science (D), Interdisciplinary (Areas C and A).

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). The number of Ph.D. schools have not a substantial variation across specialties and it remains also stable across academic years (we observe, on average, a total of 32 schools each years).

As general information, we know that the number of Ph.D. schools offered by the University of Siena in this period of observation shows a different trend, with respect to the National landscape (see the XI report CNVSU, CNVSU, 2011). In fact, while at national level between 2007/08 and 2009/2010 is observed a decreasing trend, the number of Ph.D. courses offered by the University of Siena slightly increases. Whereas, as regard to the percentage of the enrolled units who have achieved their graduation in a foreign university, the percentage is significantly higher for the University of Siena, with respect to the national

figures. Indeed, these latter show a mild but continuous increasing between the 3.2% (2003/04) to 8% (2009/10), while the percentage of the enrolled units who have achieved the graduation in a foreign university is around the 12% and even greater (around 16%) 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.

A positive mark for the University of Siena is that the group of the applicants who have achieved their graduation in a foreign university is mainly composed by students coming from countries with a very high or high Human Development Index (see HDI in Table 1) for all the academic years.

Table 1. Number of applicants (n) and % by HDI, a.y. 2007/08-2010/11, University of Siena

HDI	Academic years							
	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
Total	1216	100.00	1256	100.00	1358	100.00	1189	100.00

Some other interesting evidences are related to the number of advertised grants: the local declining trend reflects the one related to the courses supply at national level, with the strongest declining in a.y. 2009/10.

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 the 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 2).

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 2. University of Siena—pooling data: number of applicants, maintaining applicant status, winners, grants by educational field

Educational field ⁷	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 3). 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 B⁸. This heterogeneous behavior among areas justifies the large value of the c.v. computed for the whole set of Ph.D. 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 3 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 3. Mean and c.v. of single indicators by educational fields

Indicator	Educational field									
	A		B		C		D		Total	
	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 is presented in Table 4 where thirty-one schools are listed⁹ by their score on the composite indicator defined in section 3.3.

We decided not to report the scores of each indicators 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 5.

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 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 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 high degree of internationalization. Moreover they also have very poor performances in terms of polarization.

Table 4. Ranking of Ph.D. schools based on the recruitment phase, University of Siena – pooling data

Phd schools	n*	n**	Educational field	Indicators							
				Participants				Winners			
				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 several 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 5. Classification system used for defining single index performance

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

5. Some final remarks

The ranking exercise has become more and more common in recent years despite the widespread criticism of what 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 the strength and the 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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² 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.

³ In our empirical analysis we do not consider this aspect as we check several deficiencies in data.

⁴ An interesting widening of categories could be to consider applicants coming from association among universities, but empirical data do not have this information.

⁵ 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".

⁶ 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.

⁷ In the interdisciplinary area (I) there is only one Ph.D. school; therefore we merge this area with Experimental Sciences.

⁸ 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.

⁹ We included in the final ranking all Ph.D. schools for those we have information at least three for three years.