

Companies, Competences and Graduates' Selection Processes: an Attempt to Quantify

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Summary. The assessment of the employment potential of University graduates represents a direct evolution of the quality evaluation of higher education systems. This paper aims to identify competences that companies, which subscribed the Vulcano-database, require when selecting graduates for employment. Our analysis consists of two parts: one in which a quantitative score is associated through Rasch analysis to the companies' interest with respect to four classes of characteristics and competences they take into consideration when selecting candidates. In the second part, we apply a segmentation analysis to check whether there is correspondence between companies that prefer certain university degrees and the interest levels towards the characteristics and competences so quantified.

Keywords: Rasch analysis; Segmentation analysis; Rumm; C@rt; Graduates' competences.

1. A survey on companies' interests

Studies on self-assessment of work experience and career expectations of university graduates draw a general picture of graduates' transition from higher education to employment in Italy. Instead, studies on companies' interests are less frequent.

The awareness about the candidates' features companies consider relevant in the recruitment process may help universities to improve their educational offer.

This paper refers to a CATI survey carried out by Checchi & Pravettoni

¹ In this joint work, M. Civardi was responsible for the final editing of Sections 3, whereas E. Zavarrone was responsible for the other Sections.

(2004) at Milan State University² in 2003. The survey was conducted on a non-probability sample of 278 companies, out of the 476 that subscribed for at least one year the services of Vulcano database since its start in February 1998.

Vulcano database was set up in cooperation with Cilea³ to link university graduates and the companies. It is a free access service for graduates, who are given a password by their own university for writing and possibly editing their curriculum vitae (CV). Companies can have either free or fee access to the database for recruitment purposes.

The survey aimed to identify companies' structural characteristics and their willingness to collect some information about the candidates' profiles and competences from the database.

"Sections" D6, D7, D8 and D9 of the questionnaire suited the objectives of this study. The aim of these questions was to measure the importance companies attributed to four classes of "characteristics and competences" of graduates. Each section consists of a set of items obtained on a 4-grade ordinal scale ranging from 0=no interest to 3 = greatest interest.

2. Methodology and application context

The following data were analysed:

- the items of section D6 derived from graduates' administrative records (age, sex, schooling, grades, dissertation topic) edited by the university services;
- graduates' curriculum (study experience abroad, foreign language skill, IT skill, internships, military service), described in section D7;
- skills evaluated by companies at graduate's recruitment stage (communicating, speaking, listening, synthesising, emotion control, concentration, understanding different points of view, flexibility, problem solving, honesty, creativity, self-confidence, study and career expectation consistency), described in section D8 of the questionnaire;
- other competences the companies take into consideration while evaluating candidates for recruitment (behavioural, relational, and organisational attitude and professional skills), described in section D9 of the questionnaire.

² We are grateful to the Authors and to COSP (Centre for Study and Career Advice) of Milan State University for consenting us to use of micro data.

³ CILEA, established in 1974, provides Information and Communication Technology services on behalf of universities and related organizations, public organizations and enterprises. It provides also professional advice for both the planning and dissemination of advanced technologies in the fields of high performance computing, networking services and informatics.

We applied the Rasch method to estimate the relevance of each one of the four dimensions. This method creates a metric scale for each dimension and places both the characteristics of the selection process and the companies on an underlying continuum. This continuum reflects the ideal candidate's profile between the two extremes of "no importance" on the left and that of "highest importance" on the right. The Rasch results are two-fold: the *subject's ability* (i.e. his/her propensity towards the latent continuum) and the *item difficulty* that identifies the position of each item on the latent continuum (Wright & Masters, 1982).

With reference to our application, subjects are the companies, while item difficulty is the importance assigned to a specific graduate's feature by companies. The subject's score is obtained through the scores the companies assigned to the items; the item difficulty is the level of companies' endorsement of the items.

As response items are ordinal, we chose a Partial Credit model to fit the data. This model is based on the hypothesis that the ability of the i -th subject to pass from one response scores to the next can vary according to items. According to Rasch's terminology, if $Y=0, 1, 2, \dots, k_j$ is the ordinal response vector for the j -th item, the difficulty of indicating score y in item j for a subject is larger than the difficulty of each response placed below y in the scale.

Therefore, if δ_{jy} expresses the difficulty to indicate score y for item j :

$$\delta_{jy} = \sum_{w=0}^y \delta_{jw} = \sum_{w=0}^y (\delta_j + \tau_{jw}), \tag{1}$$

δ_j indicates the mean difficulty of the j -th item, while τ_{jw} the threshold of the scores preceding scores y . The probability π_{ijy} of subject i to respond y to item j is obtained by:

$$\pi_{ijy} = \frac{\exp \sum_{w=0}^y (\beta_i - \delta_{jw})}{\sum_{q=0}^{k_j} \exp \sum_{w=0}^q (\beta_i - \delta_{jw})}, \tag{2}$$

where β_i is the ability of subject i . For a subject i , the natural logarithm of the ratio between his/her probability to assign score y to item j and the probability to score $y-1$, is represented by a multi-parametric logistic model:

$$\ln \left(\frac{\pi_{ijy}}{\pi_{ij(y-1)}} \right) = \beta_i - \delta_{jy}. \tag{3}$$

Expression [3] determines the value of ability β_i , the core dimension of the analysis. In fact, β_i indicates the position of a company on the continuum and varies between "no importance" (minimum β_i) to "very large importance" (large positive β_i).

Table 1. Ability scores descriptive statistics for the four dimensions, full sample

	<i>D6</i>	<i>D7</i>	<i>D8</i>	<i>D9</i>
Sample size	278	278	186	278
Mean	-0,681	-1,083	1,160	1,741
Variance	2,689	3,610	0,785	0,660
Percentile				
10	-3.590	-4.323	0.159	0.759
20	-3.590	-4.323	0.562	1.119
30	-0.744	-1.086	0.842	1.245
40	-0.233	-0.697	1.026	1.509
50	0.013	-0.508	1.221	1.650
60	0.136	-0.108	1.221	1.861
70	0.391	0.111	1.431	2.129
80	0.524	0.344	1.664	2.319
90	0.812	0.873	2.251	2.783

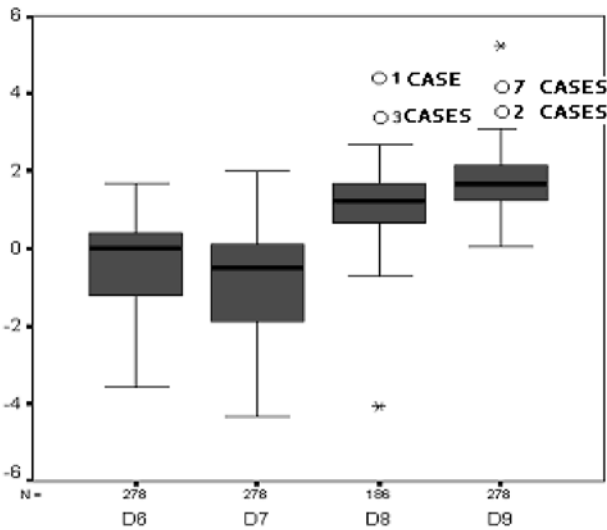


Figure 1. Ability scores statistics for the four dimensions, full sample.

Descriptive statistics of ability score for the four latent dimensions obtained with Rasch analysis, using Rumm software, are presented in Table 1 and Figure 1.

The ability scores for dimensions D6 (official graduates' CV) and D7 (general competences for work) present the greatest variability. Companies showed different levels of interest towards these two dimensions.

The mean values for these two dimensions are smaller than those for D8 and D9, which concern the features the companies regarded as highly desir-

able. We can conclude that the information stored in the Vulcano database are less relevant for the companies.

Nevertheless, 92 out of the 278 sampled companies did not associate any score to D8, in fact, they did not answer to these questions. Consequently, a second analysis was carried out on the subset that evaluated all items. Table 2 and Figure 2 show results of this more pertinent analysis.

Table 2. Ability scores descriptive statistics for the four dimensions, companies responding to all items

Sections	D6	D7	D8	D9
Sample size	186	186	186	186
Mean	0.121	-0.134	1.160	1.747
Variance	0.569	0.793	0.785	0.586
Percentile				
10	-0.650	-1.086	0.159	0.877
20	-0.357	-0.697	0.562	1.119
30	-0.110	-0.678	0.842	1.245
40	0.111	-0.313	1.026	1.509
50	0.260	-0.108	1.221	1.650
60	0.391	0.111	1.221	1.798
70	0.524	0.344	1.431	2.129
80	0.663	0.597	1.664	2.319
90	0.975	0.965	2.251	2.533

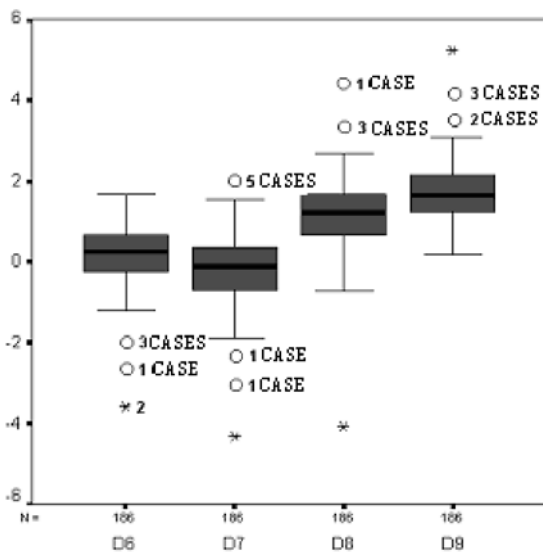


Figure 2. Characteristics/competences ability score box-plot - selected sample

Table 3. Correlation matrix, full sample

	<i>D6</i>	<i>D7</i>	<i>D8</i>	<i>D9</i>
D6	1	,906	0,115	-0,029
D7		1	0,217	0,006
D8			1	0,535
D9				1

Table 4. Correlation matrix, partial sample

	<i>D6</i>	<i>D7</i>	<i>D8</i>	<i>D9</i>
D6	1	0,487	0,115	0,145
D7		1	0,217	0,191
D8			1	0,535
D9				1

The greatest difference between the two analyses concerns dimensions D6 and D7, whose scores are much more homogeneous in the subset sample than the full one. In particular, this subset expressed the highest scores, the ones closer to the greatest importance extremity. On the contrary, there is no difference between the characteristics/competences taken into consideration at the time of the interview and the “ideal competences” expressed by D8 and D9 sections.

Tables 3 and 4 indicate values of linear correlation coefficients *r* between each pair of graduates’ features, respectively for total and partial samples. For both, the score associated to D6-D7 and D8-D9 pairs are significantly correlated. D7 and D8 are also correlated, although with a lower *r* value. In the subset sample, D6 and D9 are correlated, too, at 5% significance level.

3. Ability scores for graduates’ competences

The ability scores show the importance assigned to the four graduates’ features by companies at the recruitment stage. This raises the question whether different importance levels for each dimension correspond to the type of degree in which companies are interested. If that is the case, on the one hand, university degrees preferred by companies can be predicted. On the other, it can help the definition of an appropriate university formative offer.

We used a segmentation analysis for this purpose. This method detects groups of units characterised by maximum differences on a criterion variable according to a set of binary splits on selected covariates. In this analysis, the criterion variable was the proportion of companies that consulted the Vulcano

database for selecting graduates from a specific faculty. The possible predictors were the graduates' features.

We applied the segmentation algorithms implemented on the AnswerTree 3.5 (additional SPSS software) following the C@rt procedure proposed by Breiman *et al.* (1984). Gini's impurity criterion was used as the segmentation criterion, and the minimum number of units in the parent and child nodes was set, respectively, to 5 and 2. The analysis was conducted on:

1. the courses of study of Mathematics, Physics, and Natural Sciences (Science Faculty);
2. the courses of the Faculty of Political Sciences;
3. the courses of the Humanities Faculty.

The segmentation was conducted on both the 186 companies, where the full information was available, and on the 278 companies, after the exclusion of the explanatory variable D8.

3.1 Graduates in Mathematics, Physics, and Natural Sciences

For the courses of the Faculty of Sciences, the access rate to Vulcano database did not differ substantially: 62.6% out of the 278 companies had access to it in order to select graduates of these courses, while in the subset of 186 companies the proportion was 64.5%.

Within both samples, the companies interested in selecting these graduates were characterized for a score lower than or equal to 1.309 in the dimension D9, and a D7 score greater than 0.470. With regard to the whole sample, these companies occupied the lower positions (up to 30th percentile) on D9 dimension, and the top ones (above the 70th percentile) with reference to dimension D7.

In the screened sample, the significant predictors were the same of the previous analysis, but in the latter case companies scored in the D7 dimension above the 80th percentile, far above the total sample one. In both cases, dimension D6 did not show differences between companies' propensities. Therefore, the analysis seems to indicate that the companies interested in graduates of the scientific faculty of the Milan Athenaeum, beyond being the most numerous, give the maximum importance to the cross-occupational skills achieved by the graduates while, in the direct job interview, assign relatively little importance to the behavioural, relational and organizational attitudes.

3.2 Graduates in Political Sciences

With reference to the full sample of companies, the segmentation analysis identified two main groups. The first one, which is small but well characterised, consists of the companies with D7 larger than 0.470 and $2.43 < D9 \leq 3.14$.

Although D6 appears in the lowest part of the tree, it does not seem to discriminate. These companies give the outmost importance to both graduates' CVs and their behavioural, relational and organisational attitude (D7 scores are above the 80th percentile and between the 80th and the 90th percentile for D9). The second group of companies that are interested in Political Science graduates manifest a relatively small importance to dimensions D7 and D9 ($D7 \leq 0.47$ and $D9 \leq 1.579$). Again, D6 does not discriminate.

In the selected sample, the segmentation analysis identifies a small number of companies with a score higher than 1.361 for D7, while D6 scores are put together along the two distributional tails: the companies placing above the 90th percentile are particularly interested on graduates' study curriculum. Amongst the companies with a D7 score lower or equal to 1.361, D6 is discriminant. Conversely, D9 does not discriminate as it excludes less than 10% of the companies (the value of this percentile being 0.877).

In conclusion, the segmentation analysis suggests that companies that are interested in Political Sciences graduates either assign high importance to D7 or, if they consider D7 less important, they take into consideration even the administrative data.

3.3 Graduates in the Humanities

The segmentation analysis carried out on the total sample shows that amongst the companies interested in Humanities graduates, a rather consistent number show D7 scores higher than -0.210 and lower or equal to 0.002 with D6 scores between -0.684 and 0.075. D9 does not seem to be a discriminatory dimension.

These results show that the importance assigned to administrative information are very close to the median, while the importance assigned to the experience is placed just above the median (60th and 70th percentile).

In the selected sample, segmentation analysis identified companies with D7 scores between -0.210 and 0.0015. With reference to experience, the results of the total sample are confirmed. D6 does not seem discriminant. Conversely, D8 identifies companies with scores lower than 0.075, i.e. companies that give little importance to candidates' competences emerging during the selection interview.

Hence, companies interested in selecting graduates in the Humanities give a medium-high importance to study curriculum, a medium-low importance to administrative characteristics and a very low importance to competences emerging from the selection interview. All this could indicate that graduates in the Humanities are required for general administrative positions.

4. Conclusions

The quantification of the characteristics the graduates should possess for finding a job is a complex process, because of the difficulty in identifying the interactions occurring amongst the factors involved. Undoubtedly, the administrative information “certified” by the universities leads the selection process of candidates, even if the companies do not always consider it as the decisive element for recruitment. Actually, companies pay great attention to the candidates' competences exhibited at the recruitment interview stage, but conditional to their university degree.

An in-depth analysis of the three actors involved would be needed: the university, who is responsible for the making of competences offer, the graduate, as the holder of the competences, and companies, who require it. Our approach, which is based on the quantification of the importance companies assign to graduates' competences, could be the connecting link amongst the three actors.

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