An Evaluation of the Student Satisfaction based on CUB Models.

Barbara Cafarelli and Corrado Crocetta

Abstract In 2009 the Faculty of Economics of Foggia started a project called "Analisi della student satisfaction" with the aim to create an internal quality control system based on its students' feedback. Every year a customer satisfaction survey is carried out, where all attending students are asked to evaluate the services provided. This paper presents an evaluation of the satisfaction degree of the students over the last two academic years. In order to understand the level of satisfaction and the psychological mechanism behind the students' evaluation process an approach based on CUB models is adopted. At the end a multidimensional scaling has been proposed to investigate the existence of student subgroups with similar attitudes in terms of feeling and uncertainty towards the Faculty's services and their overall satisfaction about them and eventually confirm the presence of the latent variables estimated by CUB models.

Key words: CUB Models, Kullback-Leibler divergence, Multidimensional scaling.

1 Introduction

Service evaluation has become a very important issue for the Italian Public Administration as a whole, especially for the University system. In this context, the opinions expressed by attending students can be a useful tool to evaluate the efficiency of university policies. By means of the aforementioned student satisfaction analysis project, the Faculty of Economics of Foggia has developed a monitoring system devoted to improve the quality of the services provided by students' feedback. A

[1] Barbara Cafarelli, University of Foggia; email: b.cafarelli@unifg.it

Corrado Crocetta, University of Foggia; email: c.crocetta@unifg.it

customer survey was carried out over two academic years, which paid particular attention to the respondents' perceptions and to the underlying psychological construct behind them. In particular, the CUB models (see [3]) were used to assess how the judgments of the students are influenced by their personal feeling towards the items under investigation and by the inherent uncertainty associated with the choice of the ordinal values featuring on the questionnaire responses (see [5]). We hereby propose to detect significant similarities and differences between the raters' overall judgment by comparing the estimated CUB models, with the aid of a multidimensional scaling (MDS). The MDS approach is also used to confirm the presence of the two latent CUB variables and the role that they play in the satisfaction process. In this paper we only report the results of the satisfaction survey referring to the services most frequently used by the students: logistics (*L*), registrar's office (*RO*), teaching (*T*), web site (*WS*) plus the overall satisfaction about the Faculty (*OS*). The paper is organized as follows: after a brief description of the survey's characteristics and the presentation of the methodology applied, the results will be discussed and scrutinised in detail.

2 The student survey

The evaluation of the students' satisfaction about the services provided has been performed by means of a questionnaire proposed to all the undergraduates attending lectures at the Economics of the University of Foggia during the academic years 2009-2010 and 2010-2011 for a total of 968 interviews for the first analysed year and 832 for the second, respectively, the 35% and 30% of the total registered students. The services under evaluation are logistics, registrar's office, teaching, website, laboratories, library and job placements. The judgements are expressed in a Likert scale from 1 (extremely unsatisfied) to 7 (extremely satisfied).

3 The statistical procedure

The student satisfaction assessment was made by using CUB models as a means to understand how customer preferences are influenced by a subjective personal feeling (ξ) towards the item under investigation and by the inherent uncertainty (π) associated with the choice of the ordinal values featuring on the questionnaire responses. A CUB model (see [3] and [5]) is a mixture model combining a shifted binomial random variable, used to evaluate the feeling, and a discrete uniform random variable, used to express the uncertainty, as follows:

$$P(R=r) = \pi \binom{\mathbf{m-1}}{\mathbf{r-1}} (1-\xi)^{r-1} \xi^{m-r} + (1-\pi)\frac{1}{m} \quad r=1,2,...,m \tag{1}$$

where $\xi \in [0,1], \pi \in [0,1]$ r is the rating and $m>3$.

The statistical procedure proposed consists in the following steps:
1. a model (1) was fitted for each considered service as well as for overall satisfaction for each academic year (more specifically, 10 CUB models were estimated in this

study). The goodness of fit is measured, for each estimated model, by the dissimilarity index (see [5]). In this case study, this resulted to be less than 0.1 for each estimated model, suggesting a very good fit. The model (1) was estimated by using software `CUB.R (2.0)` implemented in R (see [4]);

2. the ξ and π estimators are characterized by different variability patterns and play a different role in determining the shape of the estimated distributions (see [1] and [2]). In particular, the use of the Euclidean distance might cause misleading interpretations of the CUB models in the parameter space (see [2]). For this reason, the Kullback-Leibler (KL) divergence was used to evaluate the dissimilarity among the estimated rating distributions (see [1]). A non parametric multidimensional scaling approach based on KL divergences was then applied to assess the presence of dissimilarities between the performance of the various services provided and the overall quality of the Faculty over the two investigated years with the purpose of detecting relevant differences among the services issued.

4 The results of student satisfaction survey

The values of the estimated CUB parameters suggest a good level of satisfaction and a low level of uncertainty among the respondents: the feeling parameter $\hat{\xi}$ ranges between 0.25 and 0.49 and the estimated uncertainty parameters ($\hat{\pi}$) are greater than 0.61, which means that the interviewees are quite precise when it comes to giving marks (Fig.1, a). However, in the second academic year the examined services show worse performance levels compared to the first year, with the only exception of teaching. There is also an increase in the amount of respondents' uncertainty. The logistic services and the registrar's office are characterized by similar feelings but different levels of uncertainty over the two years under investigation and they are always considered by the students as the services with the less satisfying performances. The students have a strong positive feeling and a very low level of uncertainty towards teaching over the two years. A similar behaviour is reflected in the results for the overall satisfaction parameter during the first year. The students always assign high ratings to the website's performance even though there is a sensible decline in terms of both feeling and uncertainty in the second year. The CUB estimated distributions are skewed to the left and are quite similar in median and mode (Fig.1, b and c). In particular, logistics and registrar's office show a similar behaviour for each academic year (Fig.1, b). Teaching, overall satisfaction and website show a quite similar pattern too (Fig.1, c). Moreover, website and teaching achieve the highest performance ratings over the two years. These graphical evidences have been checked by means of a multidimensional scaling analysis (Fig.1, d). By using this method, the presence of dissimilarities between the performances of logistics and registrar's office over the two academic years, and those among the other services analysed was confirmed. The similarity between teaching and the overall quality of the Faculty were also confirmed over the two years. Moreover, the multidimensional scaling approach adopted confirmed the presence of the aforementioned two latent dimensions in the psychological construct that shapes the respondents' behaviour, as suggested by a CUB based analysis, i.e. ξ (coordinate 1) and π (coordinate 2).

5 Conclusions

CUB models provide a very useful methodology to understand the psychological mechanisms behind the students' evaluation process and they can be used as a valuable tool to compare ratings expressed on different services. Corduas (2008) suggests to avoid the problems connected to the interpretation of the feeling and the uncertainty in the parameter spaces by clustering ordinal data in order to detect statistically-relevant similarities among distribution patterns. In this paper, the multidimensional scaling approach is specifically used to understand the similarities existing between students' judgments and to detect those meaningful underlying dimensions that allow the researcher to explain observed similarities between the investigated items.
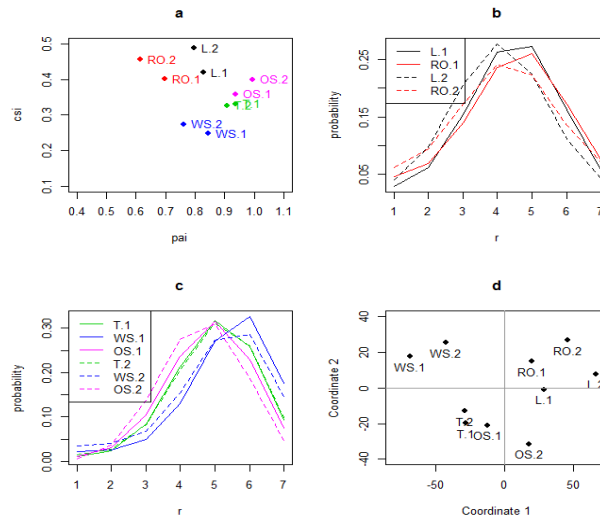

Fig. 1: Results of the student survey: a) feeling and uncertainty estimated by CUB models; b) theoretical distributions of logistic and registrar's office estimated by CUB models; c) theoretical distributions of teaching, website and overall satisfaction estimated by CUB models; d) MDS map.

References

1. Corduas M.: A statistical procedure for clustering ordinal data, Quaderni di Statistica, **10**, 177-187 (2008)
2. Corduas M., Iannario M., Piccolo D.: A class of statistical models for evaluating services and performances. In: Bini M. et al. (eds). Statistical Methods for the Evaluation of Educational Services and Quality of Products. Contributions to Statistics, 99-117, Physica-Verlag, (2009).
3. D'Elia A., Piccolo D.: A mixture model for preference data analysis. Computational Statistics and Data Analysis **49**: 917-934 (2005)
4. Iannario M., Piccolo D.: A program in R for CUB models inference, Version 2.0, available at www.dipstat.unina.it (2009).
5. Iannario M., Piccolo D.: A new statistical model for the analysis of Customer Satisfaction. Quality Technology & Quantitative Management, **7**; 149-168 (2010).