Jobs and Competences of Graduates in Statistics

Maria Cristiana Martini, Luigi Fabbris[1]

Statistics Department, University of Padua, Italy

Summary. The aim of this paper is to analyse the competences used at work and the professional profiles for people who graduated in Statistics at the University of Padua. Our study, accomplished by means of correspondence analysis and cluster analysis, highlights a general consistency between the formative profiles modelled at the Statistics Faculty and the tasks performed by graduates. Moreover, our analysis points out that several graduates are working in clerical jobs that do not allow them to use the competences they achieved during their university studies.
Keywords: Jobs; Competences; Educational profiles; Graduates in Statistics; University of Padua; Correspondence analysis; Cluster analysis.

1. Why an analysis of competences?

In Italy, tertiary education in statistics is traditional at any programme level, bachelor, master and PhD. The placement of graduate statisticians on the job market has always been easy, at least in comparison with other non-technical types of study programmes (Fabbris *et al.*, 2002).

Statistics is not a regulated profession in Italy[2]. Nevertheless, statistical skills are strongly required by the market and statisticians are required for a variety of jobs. Statisticians work in agencies of services supply, craft and

[1] This note has been edited by L. Fabbris for Section 1 and by M.C. Martini for the other sections.

[2] In fact, that of actuarial statistician is a regulated profession in Italy, but the Paduan Faculty of Statistics does not supply the specific degree required for the admission to this position. A graduate in Statistics can take an exam to qualify in Statistics for the public administration, but this qualification is not really valued.

industrial companies of any size and activity, agencies for public opinion surveys, central and local public administrations, professional offices, and cooperative societies of services.

The knowledge and skills in demand concern marketing research, information systems management, industrial production and provision of quality control, demographic, social and economic forecasts, different types of counselling, technical support to activities of certification, goods and services quality control, technical offices, research and experimentation for goods and processes development.

However, statisticians are at a disadvantage because the poor knowledge of their professional potential: entrepreneurs and managers perceive the importance of statistics, but are not fully aware of the work duties a statistician can realize. Moreover, the extent of statistical activities rarely requires a "whole" statistician. This means that, in general, the statistical tasks are associated with other tasks and graduates in Statistics are often employed as computer scientists, business economists, and other capacities.

The variety of roles and contexts where the statisticians operate makes it more difficult to identify the professional profile of graduates in Statistics. The functions that a statistician exerts, in fact, are common to almost all the companies and institutions and, with few exceptions, to the functional areas where statisticians are engaged.

The condition of statisticians is common to most qualified workers. In small and medium companies, and in particular in professional offices, graduates are hired to carry out a multiplicity of functions, one of which – hopefully but not necessarily the main – referring to his or her educational subject.

The key to define the work activities carried out by statisticians, and to shape their professional profiles, are the competences they use. Competences are cross-occupation and job-specific kinds of knowledge and skills, and attitudinal features useful to work in a complex working environment, such as the capability to work in team, to feel him/herself part of a whole, to detect and concretely solve company's problems.

Technical competences can be taught at school. Attitudes are believed to be a sort of personal heritage. Nevertheless, with suitable educational methods, it is possible to develop even professional attitudes. For example, working in team is an attitude that can be instilled by studying in a team, so that students understand the value of a so-called "professional democracy", the necessity of reaching a shared solution while being able to argue in favour of their own ideas. Analogously, problem-solving abilities can be developed by focusing on problems instead of methods at some points during their university studies.

Competences represent the parameters of a professional profile, its suitability for working purposes. Knowledge, skills and attitudes, whose achievement starts at school, can be used to satisfy work needs. Hence, competences are the elementary units for comparing professional profiles and work needs and, too, for describing the contents of formative curricula and jobs.

In the following, we will describe the competences used by graduates in Statistics (Section 2). We will also try to understand if either the competences used at work are the same, apart from content specificities, or the occupations of statisticians are so culturally and technically different that we cannot define a single professional figure of statistician but distinct ones (Section 3).

We will analyse the answers given by 145 bachelor and master graduates in Statistics at the University of Padua. The graduates were interviewed by telephone six months after graduation (Fabbris, 2003). A number of 99 out of 145 had a job and answered about their work activities.

The use of competences in their working experience has been assessed by means of 23 closed questions. The jobs in which the graduates in Statistics were engaged have been collected by means of a partially closed question based on a list of typical jobs and the possibility to specify the job in a verbatim form. In several cases, instead of directly coding the job, interviewers preferred to record it in a verbatim form.

2. Competences of the Paduan graduates in Statistics

Martini (2003) found that graduates in Statistics find a job in a relatively short time, get a fair income and are fairly satisfied for their job, but their jobs and study curricula are weakly consistent. Hence,

- which competences do graduates really use, and
- what are the ones they feel they miss?

The given answers (Table 1) show that new graduate in Statistics use some specific competences acquired at university, but are employed mostly as computer scientists. It is not surprising that the employed statisticians use social and demographic competences less than the economic ones, since the frequency of economics and business courses overwhelms that of socially oriented courses.

In order to study the relationships between pairs of competences, we built a square symmetric matrix whose general element, for each crossed pair of competences, is the frequency of graduates who reported the use of these competences. This matrix can be considered a complete social network (Scott, 1991) whose nodes are the competences, strengths and the intensities of common use in a given work activity. Ideally, the intensity is inversely proportional to the Euclidean distance between paired competences.

We conducted a hierarchical agglomerative cluster analysis on competences with Ward's, complete linkage and single linkage methods (Fabbris, 1997). The cophenetic correlation coefficients (Sokal & Rohlf, 1962) were, respectively, 0.83, 0.91 and 0.86. This indicates complete linkage as the most adequate method to represent our data and, consequently, that competences tend to cluster.

Table 1. Percent distribution of competences use levels for people who graduated in Statistics at the University of Padua and work six months after graduation (n=99). Within brackets the label of competences represented in Figure 1

	Not at all	*Scanty*	*Fair*	*High*	*Total*
Use of official data (sources)	42.4	20.2	23.2	14.2	100.0
Survey design (survey)	57.6	24.3	14.1	4.0	100.0
Sample design (sample)	52.1	26.5	14.3	7.1	100.0
Experimental design (exper)	52.5	24.2	18.2	5.1	100.0
Experimental results analysis (exp_res)	38.4	19.2	27.3	15.1	100.0
Computer programming (program)	26.3	10.1	29.3	34.3	100.0
Use of statistical packages (package)	49.5	13.1	21.2	16.2	100.0
Simulations (simulation)	46.5	24.2	21.2	8.1	100.0
Multivariate analysis (multiv)	48.5	19.2	20.2	12.1	100.0
Socio-demographic analysis (social)	60.2	16.3	14.3	9.2	100.0
Economic analysis (economic)	39.4	14.1	26.3	20.2	100.0
Demographic forecasting (demography)	76.5	13.3	7.1	3.1	100.0
Economic forecasting (forecast)	49.0	13.3	24.5	13.2	100.0
Social services design (social_prog)	76.8	12.1	7.1	4.0	100.0
Budget analysis (balance)	43.9	14.3	23.5	18.3	100.0
Management control (manage)	43.4	19.2	24.3	13.1	100.0
Service quality evaluation (quality)	43.9	21.4	25.5	9.2	100.0
Market research (research)	63.7	21.2	11.1	4.0	100.0
Indicators for decision design (indices)	39.4	15.1	27.3	18.2	100.0
Writing research reports (report)	40.2	15.5	29.9	14.4	100.0
Internal communication (experts)	31.3	18.2	25.3	25.3	100.0
Use of multi-media tools (audiovis)	36.4	28.3	15.1	20.2	100.0
English and other languages (language)	34.3	28.3	23.2	14.2	100.0

The analysis of the resulting dendrogram (Figure 1) highlights three groups of competences:

- one related to economics and management curricula,
- another to socio-demographic curricula
- an independent group of basic competences.

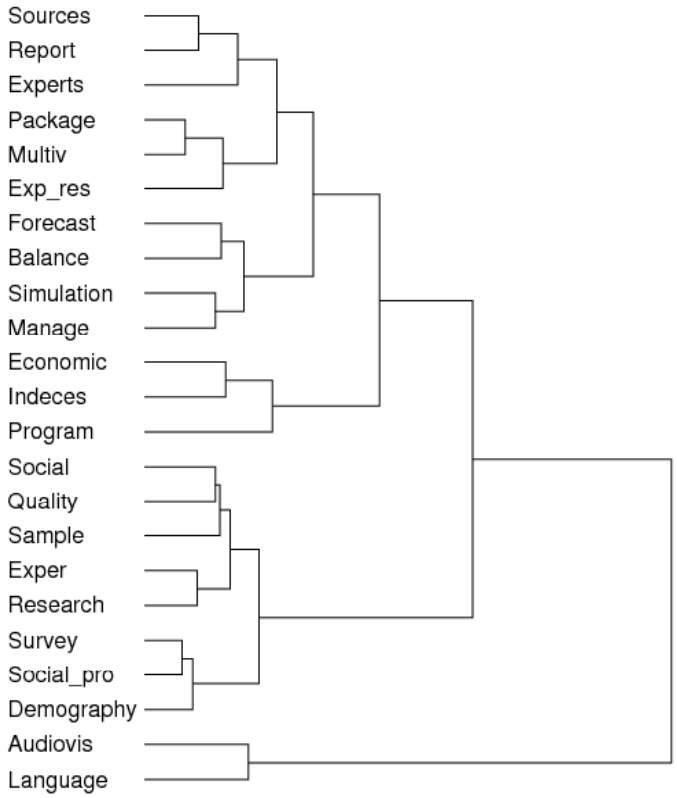

Figure 1. Dendrogram from the cluster analysis on competences (between-competences Euclidean distance; complete linkage analysis)

3. Jobs as combinations of competences

The long list of collected professional figures made it necessary to aggregate the jobs of statisticians into 11 categories (Figure 2). It is clear that non-statistical jobs prevail among those graduates. They relate mainly to computer science, general clerical works, teaching, and to a residual category that cannot be logically associated to any of the other categories (among the others, waiter, call-centre operator, building surveyor, worker, but also consultant, census coordinator, and so on).

Either such a large number of graduates with vaguely consistent jobs may depend on the fact that some of them already worked before graduation, and remained in the same position after it, or that other graduates, as newcomers, were assigned a marginal professional position.

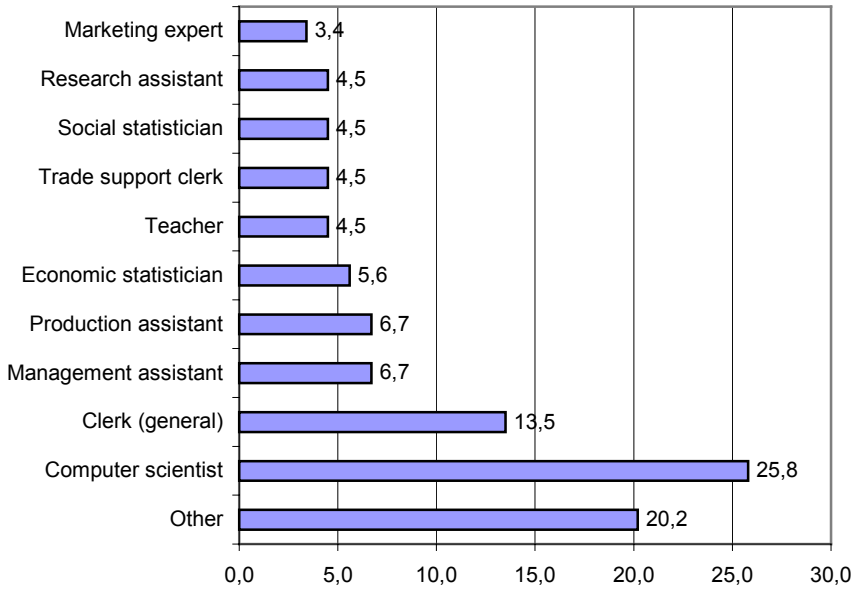

Figure 2. Percent distribution of Paduan graduates in Statistics jobs

In order to define the relations between competences and jobs, we carried out a correspondence analysis (Benzécri, 1979) on the 23 dichotomized competences[3]. Then, we projected over the factorial axes the identified jobs and some general characteristics of graduates (gender, type of programme) and of their work (satisfaction for job, consistency between job and curriculum, use of *forma mentis*, work status before graduation).

The data were processed with CORRESP procedure of package SAS (SAS Institute, 1994, 2000). In Table 2, we report the factor coordinates for each answer category of the active variables, and in Table 3 the coordinates of the supplementary variables. The scree test shows the existence of a unique factor[4]. Nevertheless, to ease the analysis, a second dimensions is represented in Figure 3.

The first dimension represents the general use of competences acquired during university studies, and shows juxtaposition between the use and non-use of competences. The main contributions for the use of competences are given by the use of official data, socio-demographic and economic analyses, economic forecasts, research reports, and decisional indicators, all competences that suggest qualified professional activities. Opposite we see the non-use of spe-

[3] In order to avoid the unwanted influence of the ordinal items on correspondence analysis, the answers on competences have been dichotomized into "Use" ("Fair" + "High") and "Non use" ("Not at all" + "Scanty").

[4] The first two dimensions explain 81.6% and 11.9% of Benzécri (1979) adjusted inertia.

Table 2. Factor coordinates on competences used by Paduan Graduates in Statistics

	Coordinates			*Coordinates*	
	1	*2*		*1*	*2*
Use of official data sources	0.77	0.03	*No demographic forecast*	-0.10	-0.19
No use official sources	-0.46	-0.02	*Economic forecasting*	0.77	-0.54
Survey design	0.86	1.27	*No economic forecasting*	-0.48	0.33
No survey design	-0.18	-0.27	*Social services design*	0.81	1.74
Sample design	0.63	0.58	*No social services design*	-0.10	-0.21
No sample design	-0.17	-0.15	*Budget analysis*	0.63	.0.61
Experimental design	0.77	0.28	*No budget analysis*	-0.43	0.42
No experimental design	-0.24	-0.09	*Management control*	0.64	-0.34
Experiment analysis	0.60	0.10	*No management control*	-0.40	0.21
No experiment analysis	-0.47	-0.07	*Service quality control*	0.65	0.40
Computer programming	0.52	-0.17	*No services control*	-0.30	-0.19
No computer programming	-0.91	0.30	*Market research*	0.75	-1.20
Use statistical packages	0.64	0.40	*No market research*	-0.11	0.18
No use statistical packages	-0.40	-0.25	*Decisional indicators*	0.68	-0.11
Simulations	0.64	-0.71	*No decisional indicators*	-0.56	0.09
No simulation	-0.27	0.30	*Research reporting*	0.77	0.15
Multivariate analysis	0.67	0.31	*No research reporting*	-0.55	-0.11
No multivariate analysis	-0.33	-0.15	*Internal communication*	0.54	.0.09
Social data analysis	0.94	0.83	*No inter. communication*	-0.53	0.09
No social data analysis	-0.28	-0.25	*Multimedia tools use*	0.70	-0.13
Economic analysis	0.69	-0.45	*No use multimedia tools*	-0.33	0.06
No economic analysis	-0.59	0.38	*Foreign languages*	0.60	0.12
Demographic forecasting	0.95	1.77	*No foreign languages*	-0.36	-0.07

cific competences and especially the non-use of computer skills. This may be considered the negative pole of this dimension. Because the non-use of computer skills is at the extreme of the non-use of statistical competences, we can say that computer skill is the professional *minimum quantum* for a graduate in Statistics.

The second dimension contrasts the socio-demographic and economic kinds of competences. Along this axis, the main contributions come from survey design and social services design, demographic forecasts and socio-demographic analyses on the one side, and marketing research, simulations and budget analyses on the other.

We observe that the activities of clerks and teachers lie in the area of non-use of specific competences, together with the residual category. Graduates employed as computer experts do not use but basic competences.

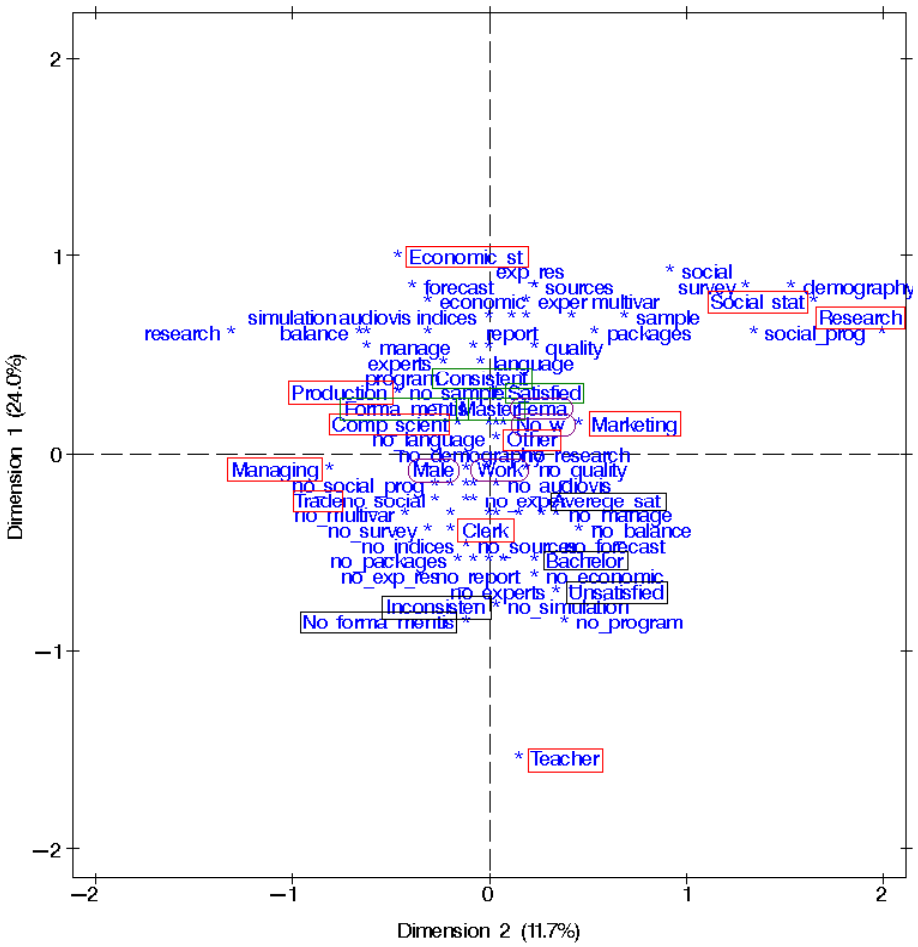

Figure 3. Correspondence analysis on use of competences for Paduan graduates in Statistics with profession, gender, type of programme, working status before graduation, job satisfaction, consistency, use of forma mentis, and need for educational qualification as supplementary variables.

Among the jobs related to the socio-demographic field we find the social and bio-statisticians that use the acquired competences to the largest extent, the assistant to research, and the assistant to marketing[5].

[5] The distance between the professions in the marketing area, in the socio-demographic part of the display, and the competence of marketing research design, in the extreme side of the economic zone, is rather curious: although marketing research is an activity for economic statisticians, in practice it is realized with competences formed in the social study programmes.

Table 3. Factor coordinates and quality (sum of partial contributions) for each answer category of the supplementary variables

	Coordinates			*Coordinates*	
	1	*2*		*1*	*2*
Research area	0.19	1.95	*No work before graduate*	0.12	-0.02
Social, heath statistician	0.67	1.53	*Master programme*	0.19	-0.06
Marketing expert	0.17	0.40	*Bachelor programme*	-0.36	0.11
Economic statistician	0.95	-0.38	*Unsatisfied with job*	-0.87	0.21
Production assistant	-0.03	-0.70	*Fairly satisfied with job*	-0.24	-0.09
Commercial assistant	0.03	-0.63	*Satisfied with job*	0.39	0.04
Management assistant	0.22	-1.04	*Job consistent curriculum*	0.54	-0.02
Computer scientist	0.25	-0.02	*Job inconsistent*	-1.01	0.03
Teacher	-1.45	-0.06	*Use forma mentis*	0.27	0.05
Clerk (general)	-0.75	-0.25	*No use forma mentis*	-1.13	-0.19
Other	-0.29	-0.12	*Compulsory school required*	-1.18	-0.16
Male	-0.25	-0.13	*Secondary school required*	-0.45	-0.38
Female	0.19	0.10	*University degree required*	0.55	0.30
Worked before graduation	-0.32	0.06			

On the economic side, we find both jobs associated with a massive use of competences, such as the economic statistician – the highest position on the first factor – and others associated with a limited use of competences, like the clerical positions in trade, management and production activities.

We observe a tendency for females to work in the social area and use more competences than males in consequence of the larger frequency of socio-demographic courses by female students.

Those who worked before graduation use competences less than those who entered the job market after graduation. This may depend on the likelihood that, six months after graduation, most of them may have maintained the same job they had before, which obviously did not require a university education.

The extreme positions on the first factor regard job-curriculum consistency, job satisfaction and systematic use of *forma mentis*. The non-use of competences is associated with unsatisfactory and inconsistent jobs, which exclude the use of a "statistical *forma mentis*". The second factor has no extreme values on any of the supplementary variables, apart for types of job.

In general, the professional activities of graduates in Statistics are consistent with the underlying competences, so that we can imagine jobs as combinations of competences. Hence, jobs of newly recruited graduates in Statistics can be considered as a "basket" whose content is the required knowledge, skills and attitudes.

Finally, we identified similarity between jobs according to the type and intensity of competence use. We carried out a hierarchical agglomerative cluster

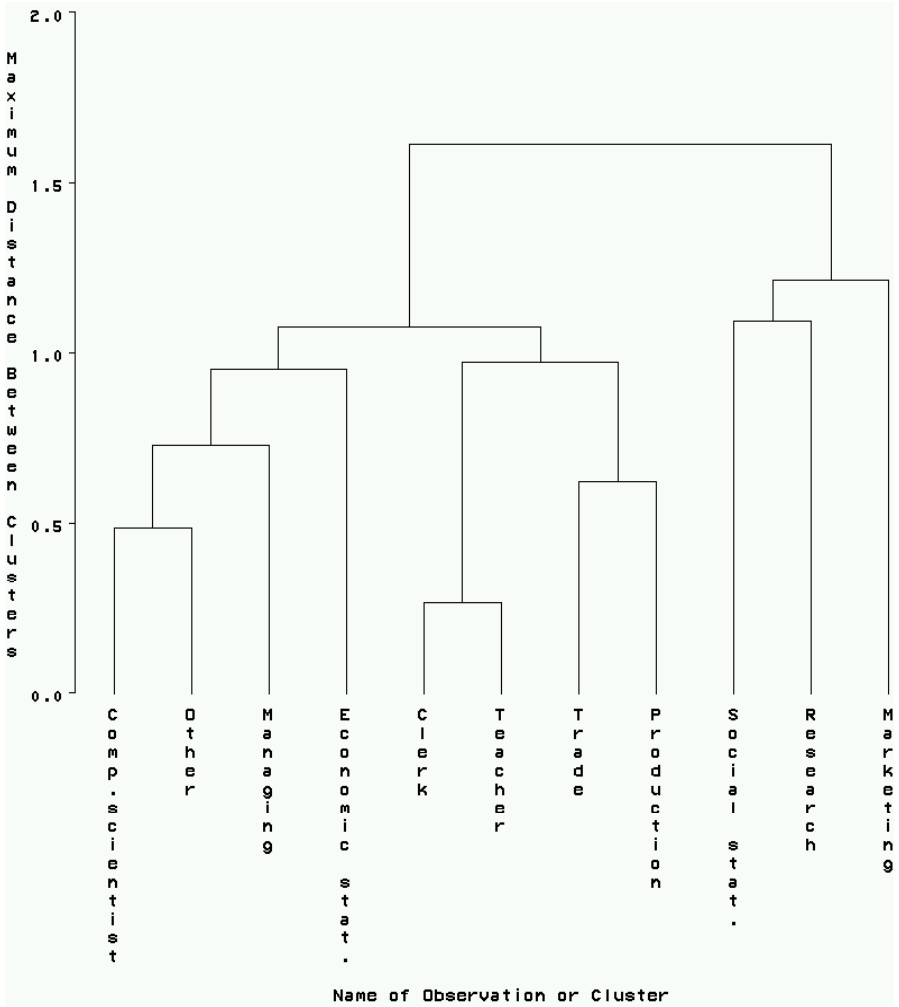

Figure 4. Dendrogram from cluster analysis on jobs of Paduan graduates in Statistics (Euclidean distance, complete linkage)

analysis on this matrix, using the complete link and the single link methods. The cophenetic correlation coefficient computed for the three applications indicates complete link as the preferable method, and this allows us to identify clusters of jobs.

The dendrogram analysis (Fig. 4) suggests the existence of two groups of jobs, one typical of socio-demographic jobs and another typical of economic and business activities. The economic area includes also jobs that make scarce use of statistical competences, such as teaching and general clerical positions.

4. Final remarks

The analysis of competences of graduates in Statistics highlighted a heterogeneous situation where, together with small groups of graduates who use refined statistical competences, a majority of graduates applies just a little of the knowledge acquired at school.

The competences graduates use the most are cross-occupation and we put forward they should be cross-curriculum: foreign language skills, computer skills, communicational, relational and organizational skills. It is relevant to be able to communicate with experts on other-than-Statistics subjects and write research reports.

Highly qualified statistical competences are the skill of identifying indicators for decision-making, that of analysing economic phenomena and company's budget and the skill of interpreting the results of multivariate analyses and experiments.

We stressed the relevance of computer skills for a graduate in Statistics to find a suitable job. Nevertheless, the graduates employed as computer scientists may get frustrated in the end because this occupation is barely compatible with statistical activities.

For those who use the acquired competences, the professional activities substantially reflect their formative curricula. A professional profile made of organizational and substantive competences in the field of company management, economic analyses, computerized support to production, R&D and commercialization activities, echoes the courses in the economics and business fields.

On the other hand, the socio-demographic curricula corresponds to professional profiles mainly employed in support-to-research activities, health and community services, marketing research, where competences on survey methodology and data analysis, design and evaluation of social policies, projects and services, demographic and qualitative analysis are needed.

The framework does not change if we concentrate on jobs instead of competences: in fact, we observe a tri-partition of graduates according to the type of work activity that is graduates employed in a-specific jobs, in social field jobs and in the economic and management field jobs.

The tricky aspect is the set, quite wide in terms of size, of graduates who do not use specific-to-statistics competences, cover a position that is rarely consistent with their expectations, show a low level of job satisfaction, and whose position does not require a university degree. A thorough analysis of the performed activities, of the used competences, and of the missing ones, could be useful to identify possible educational gaps and plan courses adherent to the job market needs.

References

BENZECRI J.-P. (1979) Sur le calcul des taux d'inertie dans l'analyse d'un questionnaire. Addendum et erratum à [BIN-MULT], *Cahiers de l'Analyse des Données*, **4**: 377-378.

FABBRIS L. (1997) *Statistica multivariata. Analisi esplorativa dei dati*, McGraw-Hill, Milano.

FABBRIS L. (2003) *Il monitoraggio dell'inserimento occupazionale e professionale dei laureati e dei diplomati dell'Università di Padova*, Quaderno PHAROS n. 6/2003, Osservatorio sul mercato locale del lavoro, Università degli Studi di Padova, CLEUP, Padova.

FABBRIS L. (ed) (2005) *Il repertorio delle professioni della Facoltà di Scienze Statistiche, II ed.*, CLEUP, Padova.

FABBRIS L., MARTINI M.C., ROTA G. (2002) Il valore di mercato dei titoli di laurea e diploma di Padova a sei mesi dal conseguimento. In: DELVECCHIO F., CARLI SARDI L. (eds) *Indicatori e metodi per l'analisi dei percorsi universitari e post-universitari*, Cleup, Padova: 171-194.

MARTINI M.C. (2003) Professional benchmarking of degrees at the University of Padua. In: MRVAR A., FERLIGOJ A. (eds) *Proceedings of the Seventh Young Statisticians Meeting, Metodološki zvezki, vol.21*, Ljubljana.

SAS Institute Inc. (1994) *SAS/STAT User's Guide, Volume 1 (version 6),* SAS Institute Inc., Cary, NC.

SAS Institute Inc. (2000) *SAS/STAT Software: Changes and Enhancements, Release 8.1.*, SAS Institute Inc., Cary, NC.

SCOTT J. (1991) *Social Network Analysis: A Handbook*. Sage, London.

SOKAL R.R., ROHLF F.J. (1962) The comparison of dendrograms by objective methods, *Taxon*, **11**: 33-40.