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ABSTRACT

Over 500 job advertisements in the Newsletter of the Operational Research Society are analyse to explore the skills that employers want from students and the tasks that such students are expected to perform in their jobs. There are consequences for the content of Operational Research and Management Science degrees.

Keywords: education, multivariate statistics.

INTRODUCTION

Although there is no agreed definition of what is OR/MS, few will dissent from the view that it is an applied discipline whose aim is to solve complex problems arising in the management of large organisations; Mar Molinero (1992). If we had a clear view of what those problems are, it would be possible for universities to design course structures and syllabuses that are in touch with reality. But problems continuously change and the technical approaches needed to address them also evolve. Universities train future practitioners, but universities are not always in daily touch with practice, and it is easy for university teachers to get stuck in the teaching of nice algorithms that are intellectually satisfying and easy to examine, but whose use was long relegated to the pages of industrial history. The converse is also true, there may be algorithms or approaches that have proven valuable in industry but that are still relatively unknown in academia. All disciplines evolve, but OR/MS evolves faster than most. This is natural, given its "Research" orientation and its "scientific approach" methodology. It is, therefore, relevant, to ask from time to time what it is that practitioners do. In the past this has lead to surveys of OR groups; Mingers (1991). Here we depart from the survey tradition and we examine the content of advertisements in the specialised press.

In this paper we look at 512 advertisements placed in the Newsletter of the Operational Research Society during the period January 2004 to January 2005. The aim is to explore the skills that employers require from future employees in the Operational Research/Management Science (OR/MS) area, the tasks that the employees will be expected to perform, and their employment conditions.

Advertisements are short by their very nature. They have to be selective in their content and not to state the obvious. Advertisements in the specialised press can be even more concise, as the reader is expected to be familiar with the concepts and share a culture. This gives a particular meaning to words. Take for example, the term "statistical modelling". Anyone with an OR/MS background is expected to be able to conduct statistical modelling of some kind. But, by stating in an advertisement that the job involves "statistical modelling", the prospective employer is emphasising this aspect. It is saying that the employee will spend most of the time in statistical

modelling and not in other things, such as project planning, and that the person selected to do the job will have to be specially good at statistical modelling. If it is the case that good statistical modelling skills are in short supply, this will be reflected in the salary offered. Advertisements also contain details about the work that the employee will be performing, about the place of work and about salary and benefits.

The information contained in the advertisements was translated into keywords and coded into a SPSS file for further analysis. Each advertisement was treated as a record and each keyword as a variable. The data is binary, indicating the presence or absence of a keyword in an advertisement. This created a file that was analysed using multivariate statistical techniques.

It was found that the job contained in an advertisement can be described in terms of four independent criteria: its orientation towards analysis inside the organisation, or towards the environment in which the organisation operates; the macro or micro vision of the analysis; the use of technical or judgemental elements in the analysis; and the orientation towards planning. It was also found that organisations often require micro analysis of the external environment, and that this is a consequence from the need to exploit large datasets.

The next section describes the data and offers some exploratory analysis. This is followed by a methodological section in which the model and the results are discussed. The conclusion summarises the findings.

THE DATA

The data set consists of all the job advertisements published in the Newsletter of the Operational Research Society between the 17th December 2003 and the 12th January 2005. No attempt was made to explore further back, as no correction for salary inflation was made. Some advertisements were placed by specialised employment agencies and some by individual firms. In total, information was collected from 540 advertisements, but some of them had appeared more than once and duplications were removed from the data set. This reduced the total number to 512.

The information contained in each advertisement was coded into three sets of variables: those related to the conditions that the person employed had to satisfy (requirements); those related to the activities to be performed in the job (activities); and other information such as salary, non-pay benefits, location, and experience required. There were instances when the same keyword appeared both as a requirement and as an activity. For example, some advertisements required experts in forecasting techniques to engage in forecasting sales. Thus, forecasting appeared both as a requirement and as an activity. In such cases the key word was coded twice, once as an activity and again as a requirement.

The coding of salaries presented difficulties. Some salaries included unspecified "benefits". A variable was thus coded taking the value 1 if there were benefits and zero if there were no benefits. This was clearly unsatisfactory, as benefits can take many different forms. Sometimes, salaries were described as "competitive" or some similar term. Rather than remove from the data such records, a "nearest neighbour" approach was followed to estimate a salary value for further statistical analysis. The data set was searched and jobs similar to the one with missing salary data were identified. The missing value was replaced with an estimate obtained from these nearest neighbours. Although this procedure introduces an element of error, only a small number of values were estimated in this way, and it was hoped that the statistical analysis would be robust to estimated data. Salary data was then coded into ranges (numbers in brackets indicate the number of times that this variable took the value one). The names of the variables and their definitions are as follows:

- *upto25*.- up to £25000 p.a. (134).
- *upto35*.- more than £25000 and up to £35000 (240).
- *upto45*.- more than £35000 and up to £45000 (101).
- *upto55*.- more than £45000 and up to £55000 (25).
- *upto65*.- more than £55000 and up to £65000 (10).
- *upto90*.-more than £65000 and up to £90000 (2)
- *n-benefits*.- the pay contains non-salary benefits (313).

Each one of these variables is, of course, of the zero/one type.

We can see that most advertisements are aimed at the lower end of the salary scale, the mode being between £25000 and £35000.

Missing value problems were also faced when looking at the experience required for the job. Again, when no information was available a nearest neighbour type of estimation was followed. There often was a degree of ambiguity; for example, at times two years experience was required but the experience had to be in the relevant area. To capture this difference, a distinction was made between "some experience required" and "medium level of experience required". Then five binary variables were created:

- *no*.- no experience required (245).
- *some*.- some experience; 1 or 2 years (52).
- *moderate*.- moderate experience; 2 or 3 years (104).
- *medium*.-medium experience; at least 3 years (60).
- *high*.- high experience; 5 years or more (51).

We see that jobs that do not specify experience are the most common. This, combined with the fact that salaries are often on the lower half of the range, indicates that most advertisements are aimed at relatively young people.

The location of the job produced eight zero/one variables:

- London (182)
- South (174)
- North (68)
- Midlands (60)
- Scotland (4)
- Wales (10)
- Ireland (1)
- UK (13)

Jobs that required the employee to travel through the country or abroad were classified as UK.

London and its surrounding area appear to be the most common locations for OR/MS workers.

It is evident that two advertisements may use different words to describe the same activity or to state the same requirement. Some editing was, therefore, needed in order to translate activities and requirements into keywords. The keywords finally used were as follows.

Requirements for the job:

- *rs_STA_PACKAGES*.- Skills in the use of statistical packages. This included SPSS, SAS, STATA, Eviews, R, and Ox (265).
- *rs_COMMUNICATION*.- Communication skills, including client facing skills, presentation skills, documentation, languages, liaising with others (177).
- *rs_DATABASE*.- Skills in the use of database software such as SQL, Oracle, Access, Dbase, DataQuery, and OLAP (120).
- *rs_SPREADSHEET*.- Skills in the use of spreadsheet software. Excel was often mentioned as a requirement (98).
- *rs_REGRESSION*.-Regression and econometric modelling abilities (42).
- *rs_MARKETING*.- Marketing expertise, including propensity modelling, gravity modelling, profiling, segmentation, e-commerce, campaign management tools (36).
- *rs_COMPUTER_PROGRAMMING*.- Computer programming languages. Languages specifically mentioned were VBA, MatLab, Macros, Visual Basic, C, and Java (34).
- *rs_DAT_MINING*.- Skills in the use of data mining software. We classified as such CHAID, Enterprise Miner, Neural Networks tools (28).
- *rs_MS_OFFICE*.- Expertise in Microsoft Office systems including Power Point, Word, and MS packages (27).
- *rs_MULT_ANALYSIS*.- Expertise in multivariate statistical analysis. There was specific mention of some specialised form of multivariate analysis such as Cluster Analysis, and Discriminant Analysis (26).
- *rs_FLEXIBILITY*.-Flexibility, sometimes described as mobility (16).
- *rs_SIMULATION*.- Expertise in simulation modelling (14).
- *rs_BUSINESS_INTELLIGENCE*.- Skills in the use of business intelligence packages including BRIO, COGNOS, VIPER, Powerplay, and Business Objects (14).
- *rs_GEO_INFO*.- Geographical information systems. Sometimes the advertisement just required a knowledge of geo-demographical techniques, in most cases knowledge of a package was specified. Packages mentioned included GIS, ArcInfo, SegMentz, Insight, Mosaic, MapInfo, and GeoMedia. (12).
- *rs_FORECASTING*.- Skills in building forecasting models (8).
- *rs_SIMULATION_TOOLS*.- Expertise in simulation tools such asWitness, Quest, Arena, and Simul8 (5).
- *rs_STATISTICS*.- Here we classified requests for expertise in statistical modelling such as Bayesian Modelling, Inference, and Time Series (5).
- *rs_ACCOUNTING_FINANCE*.- Accounting and Finance. Some advertisements mentioned Net Present Value calculations and Profitability Analysis (4).
- *rs_OPTIMISATION*.- Optimisation expertise. No particular techniques or approaches were mentioned (2).
- *rs_HUMAN_RESOURCE*.- Human resource management expertise including reward systems (1).

The activities to be undertaken were described with much less detail. These were:

- *as_MODELLING*.- Modelling (364).
- *as_STATISTICS*.- Statistical analysis (187).
- *as_MARKETING*.- Marketing (136).
- *as_REPORTS*.- Report writing (96).
- *as_MANAGEMENT*.- General management (59).
- *as_FORECASTING*.- Forecasting (57).
- *as_GISDAT*.- Geographical information systems data related (52).
- *as_ACCFIN*.- Accounting and Finance related (45).
- *as_PLANNING*.- Planning (40).
- *as_INFOSY*.- Information systems (34).
- *as_PRESENTATION*.- Presentation (26).
- *as_CRERAT*.- Credit rating (25).
- *as_RISK*.- Risk analysis (19).
- *as_OPTIMISATION*.- Optimisation (19).
- *as_SCHROS*.- Scheduling and rostering (18).
- *as_LOGTRA*.- Logistics and tracking (14).
- *as_SIMULATION*.- Simulation (13).
- *as_CONSULTANCY*.- Consultancy (12).
- *as_DATMIN*.- Data mining (11).
- *as_ECONOMETRICS*.- Econometrics (8).
- *as_BENCHMARKING*.- Benchmarking (8).
- *as_SOFT*.- Soft OR (7).
- *as_MANPOWER*.- Manpower planning (3).
- *as_QUALITY*.- Quality related (2).

As an advertisement may list several requirements or the employee is to engage in several activities, the numbers in brackets do not add up to 512. It is interesting to notice the importance given to computers, computing, and packages as a requirement for employment. Statistical software expertise, knowledge of database systems, spreadsheets, computer programming, data mining software, and Microsoft Office systems appear to be in higher demand than particular technical skills of an academic nature. This could, of course, be due that academic skills are presumed but so could be computing skills, as computing skills form an important part of modern OR/MS practice.

On the side of the activities to be performed, apart from modelling, which is clearly demanded in any OR/MS job, and often explicitly stated, what becomes clear is the dominance of statistical analysis over deterministic optimisation approaches. The level of statistical expertise demanded is often very high.

Communication skills require special mention. These are often stated as requirements and as activities. It is clear, and not at all surprising, that employers do not only want people who are competent at computer tools and at statistical analysis, but they also want people who can communicate their findings. Of particular interest is the follow-up stage, which is reflected in the inclusion of "tracking" as a keyword in the database.

This section has been purely descriptive in its treatment of the results. There are clear associations between keywords, and these need to be explored. For example, skills in database management are often required in order to target customer management. This will be explored in the next section.

Summarising, we have produced a table of 64 zero/one variables by 512 cases. This table will be analysed with the tools of multivariate analysis.

ANALYSIS

The data collected is kept in the form of a table of variables by cases, and it will be analysed by means of the tools of multivariate analysis, in particular ordinal multidimensional scaling (MDS) and hierarchical cluster analysis (HCA).

The objective of the analysis is to see the way in which location, salary, requirements, and activities are related. It is also important to explore if there are subsets of the variables that tend to appear in combination.

MDS is a proximity based approach to data modelling; Kruskal and Wish (1978). In our particular case we will be modelling the proximity between variables; i.e., we are interested in knowing how often two particular keywords appear together in the same advertisement.

The first step in the implementation of the algorithm is to define a measure of proximity between any two keywords. There are many measures of proximity that could be defined, but we need to take into account the fact that we are dealing with

zero/one variables; Yin and Kasuda (2005). The measure of proximity between two keywords was obtained by counting the number of times they both take the value 1 simultaneously over the 512 advertisements. This is a measure of similarity: the higher the number of times that the two variables take the value 1 in an advertisement, the more similar they are. Since there are 64 keywords, we end up with a table of 64 by 64 measures of proximity which is used as an input to the PROXSCAL routine in SPSS.

MDS configurations were created in a six dimensional space, the maximum value allowed by the PROXSCAL algorithm. The elbow test suggested that this is a reasonable dimensionality for the data, although experience suggests that not all the dimensions are needed in order to interpret the resulting configuration. As a map in a six dimensional space is impossible to interpret other than mathematically, we have to work with projections into two-dimensional subspaces. The projection on to the first and the second dimensions can be seen in Figure 1. The projection on to the third and fourth dimensions can be seen in Figure 2. No attempt was made of exploring higher dimensionality projections.

Figures 1 and 2 about here

Keywords are points in a six dimensional configuration, and it is possible for two points to appear very close in a projection while being far apart in the space. For this reason, it is sensible to perform at this stage a hierarchical cluster analysis (HCA). Euclidean distances between the points in the space have been calculated from their coordinates in the sixth dimensional space and used as dissimilarities in a HCA that uses Ward's agglomeration approach. HCA is known to be sensitive to the particular agglomeration schedule used, but Ward's approach attempts to maximise similarity between clusters while maximising dissimilarity between clusters and tends to produce reasonable results. The dendogram can be seen in Figure 3.

Figures 3 and 4 about here

Six clusters have been identified in Figure 3. Figure 4 has been obtained from Figure 1 by replacing keywords with cluster membership. The clusters are as follows:

Cluster 1 contains the following variables: South, London, Midlands, upto25, upto35, upto45, n_benefits, no, moderate, high, rs_STA_PACKAGES, rs_BUSINESS_INT, rs_DATABASE, rs_SPREADSHEETS, rs_COMP_PROGRAMMING, rs_MS_OFFICE, rs_COMMUNICATION, as_MODELLING, as_STATISTICS, as_REPORTS, as_ACCFIN, as_MARKETING, as_LOGTRA, as-PLANNING, as_GISDAT, as_INFOSY, as_PRESENTATION, as_MANAGEMENT.

This cluster groups the demand for individuals of various levels of experience who are expected to have a fair amount of technical expertise to analyse data and to summarise its main features. It clearly reflects the need to analyse large databases for decision purposes. It is also noticeable that it groups the keywords that are most often mentioned in advertisements.

Cluster 2 contains the following variables: rs_DATA_MINING, rs_MULTIV_ANALYSIS, rs_REGRESSION, rs_MARKETING.

This cluster is not very different from the previous one, except in the sense that it requires individuals to be familiar with the tools of multivariate analysis- regression could be defined as multivariate analysis- within a marketing context. This is clearly a new area for OR/MS and one that is very much in demand, as the frequency of appearance of the keywords suggests.

Cluster 3 contains: north, wales, some, as_RISK, as_CRERAT.

This cluster shows a specialised application of OR/MS analysis: risk analysis and credit rating. This work involves the use of large datasets within a multivariate analysis context, and it is not surprising to discover that there is little difference

between Cluster 2 and Cluster 3. Indeed, at a higher level of clustering they merge into a single cluster. We have preferred to keep them apart because the risk analysis activity is very different from the analysis of large databases for marketing purposes.

Cluster 4: Scotland, rs_GEO_INFO, rs_SIMULATION, rs_FORECASTING, as_QUALITY, as_SIMULATION, as_BENCHMARKING, as_DATMIN.

This is a mixed bag that appears to group together the demand for statistically oriented individuals to work in statistically oriented problems. In this sense one must remember that six-sigma approaches to quality are merely statistical analyses, and that benchmarking, as practiced in industry, is often a statistical exercise. The presence of geographical information systems as a requirement for employment, and of data mining as an activity, reflects emerging trends in OR/MS.

Cluster 5: Ireland, rs_SIMUL_TOOLS, rs_HUMAN_RESOURCE, rs_FLEXIBILITY, as_SOFT, as_MANPOWER, as_SCHROS.

The activities of scheduling and rostering, and manpower planning certainly go beyond mathematical and statistical analysis and require the use of soft systems methodologies. It is not surprising to find such activities associated with requirements for expertise in manpower planning, and simulation, and a flexible attitude to work.

Cluster 6 contains: uk, upto55, upto65, upto90, medium, rs_STATISTICS, rs_OPTIMISATION, rs_ACCOUNTING-FINANCE, as_FORECASTING, as_ECONOMETRICS, as_OPTIMISATION, as_CONSULTANCY.

The interpretation of this cluster is probably associated with the consultancy activity. Individuals with high level of qualifications are required in order to engage in very technical activities, being highly rewarded for so doing.

Turning now to Figure 1, we can see that most of the data oriented activities and requirements appear on the negative side of Dimension 1. The presence of Marketing, credit rating, business intelligence, and geographical information suggest

that this side of Dimension 1 is related to exploring the environment in which the firm operates. The other extreme of Dimension 1 contains activities such as quality, manpower planning and simulation; these activities require knowledge of optimisation, simulation tools, accounting and finance, and statistics. It is reasonable to conclude that the positive side of Dimension 1 is associated with studying how the firm operates and working out methods of optimising operations. This is the traditional realm of operational research. We conclude that Dimension 1 provides an external versus internal orientation of the analysis.

It is somewhat more difficult to place an interpretation on Dimension 2. At the top end, this dimension contains simulation, information systems, planning, and quality as activities. The requirements associated with this end of the dimension are computer programming, simulation tools, and geographical information systems. This suggests the idea of microanalysis. At the other end of this dimension we the activities of risk analysis, consultancy, econometrics, and manpower planning. The requirements associated with this end of the dimension are statistical knowledge, knowledge of accounting and finance, multivariate analysis, regression, and marketing. This suggests that the negative end of Dimension 2 focuses on analysis at the macro level. Thus, an interpretation of Dimension 2 is macro versus micro analysis.

The meaning of Dimension 3 can be gathered by looking at Figure 2. The activities associated with the left hand side of Dimension 3 are soft analysis, credit rating, risk analysis, logistics and transportation, and scheduling and rostering. The only requirement clearly associated with this activity is flexibility. If we think in terms of the way in which credit rating, risk analysis, logistics, and scheduling take place in industry, we tend to think in terms of methods that combine formal analysis tools with the exercise of judgement. At the positive end of Dimension 3 we find activities such as optimisation, econometrics, forecasting, benchmarking. These activities are to a large extent guided by very technical knowledge with little room for judgement. We can, therefore, conclude that dimension 3 captures the degree of judgement that enters into the activity.

Dimension 4, on the negative end, appears to be associated with planning activities. This can be deduced from the presence of scheduling, planning, managerial activities,

logistics and transportation, and manpower planning (not shown in the figure). The activities that appear at the top end of Dimension 4- such as data mining, soft or, and credit rating- do not appear to be related to a planning horizon.

We can summarise the above discussion by saying that advertisements that have appeared in the Newsletter of OR Society can be described in terms of four independent dimensions: external versus internal orientation; micro versus macro orientation; technical versus judgement orientation; and planning oriented or not.

Within this framework, we can see that Cluster 1, situated on the Noth West corner of Figure 1, can be described as external orientation at the micro level. This combination appears to have been very much demanded by employers, as the keywords relating to both activities and requirements within this cluster appeared most often in advertisements. But is a cluster associated with salaries from the bottom end of the range of those paid. The experience required is also at the lower end of the range. This suggests that employers are looking for recent graduates in their first jobs, and that they expect them to be well trained in information technology in order to perform data analysis.

Cluster 2, at the south west end of Figure 1 combines externally oriented analysis with a macro vision, a combination that describes well the marketing orientation earlier discussed.

Clusters 3 and 4 both appear on the north east corner of Figure 1, indicating an internally oriented micro vision. Perhaps the difference between these two clusters can be found in the fact that cluster 3 appears to be situated towards the right hand side of Dimension 3, and Cluster 4 appears to be situated on the left hand side of this dimension, indicating that Cluster 3 is oriented towards the technical while Cluster 4 is oriented towards the judgemental.

Cluster 5 appears towards the bottom end of Dimension 3 and the right hand side of Dimension 1, indicating an orientation towards the internal and the judgemental.

Finally, Cluster 6, on the south east corner of Figure 1, indicates a combination of internal orientation and macro analysis. These are the best paid jobs and the ones that combine the tools of hard analysis with highly technical abilities. The list of requirements and activities very much reflects the standard contents of a standard master course in OR: statistics, optimisation, accounting and finance, forecasting, and problem solution (consultancy). We are, perhaps, being guided by the most glamorous cluster of jobs, which is in low demand, when we devise our syllabuses and advertise our courses.

THE IMPLICATIONS FOR TEACHING OF OR/MS

If university institutions are to produce the graduates that industry demands, they should very much take into account the findings of this research. A series of lessons should be taken into account in the process of educational planning.

1. Modelling is most often included as a keyword in the advertisements. In fact, more than half of them explicitly state that the person employed will be required to engage in modelling. This emphasis is surprising, given that all the advertisements are in a specialised publication aimed at professionals whose main area of expertise is precisely modelling. What are we to conclude from this? Perhaps Industry is telling educational institutions that it does not want individuals who can reproduce the stepping stone algorithm in the transportation model, but that it wants individuals who know when to apply the transportation model, who are able to modify it, and who are able to use it to inform decision making. Industry is pleading for educational institutions to train students how to think, and is not interested in elegant solutions to past problems.
2. Most advertisements require students to be familiar with computer packages, databases, and computer decision tools. This is clearly a consequence of the world in which we live. Data is easily generated and stored. There is a need for individuals to be able to process data and extract relevant information from it. Given the large amount of data, the emphasis is not in carefully developing in-house analysis methods, but in quick and, possibly, dirty methods to

generate intelligence. Such intelligence is often required for marketing purposes and, indeed, marketing expertise is high in the list of requirements.

3. Communication skills are crucial. As both the world of data gathering and data analysis become more and more technical, the ability to put across a complex analysis message is paramount.
4. Statistical skills are often mentioned in one form or another, both as requirements and as activities. Data mining, multivariate analysis, risk analysis, quality control, simulation, forecasting, segmentation, and geographical analysis require a clear understanding of statistical reasoning. Statistics is a hard subject to teach and to understand, but no shortcuts can be taken.
5. To train future professionals in the skills that industry demands, students should be exposed to standard datasets. This means that educational institutions should be subscribing to standard databases, such as company accounts databases, population censuses, and other specialised data sets. These should then be used within a teaching context in such a way that students learn to use them and to produce relevant analyses. This can, of course, be very expensive.
6. The traditional syllabus of an OR/MS course, including highly satisfying but seldom demanded techniques, such as Dynamic Programming and Queuing Theory, should be thoroughly revised. New subjects such as Data Mining, Heuristics, and some aspects of Multivariate Analysis should replace them.

CONCLUSION AND DISCUSSION

Job advertisements in the specialised press are the way in which employers communicate their needs to the outside world. These advertisements can be read as a cry for help from teaching institutions, as employers are telling them what skills are needed the contexts in which they are to be applied. But advertisements are read by recent graduates, when there is little that can be done to match what universities produce with what employers require. Perhaps employers and educators do not communicate in a way that each other can have a meaningful conversation. But it has

been argued in this paper that the tools of multivariate statistical analysis can contribute to making communication easier by highlighting educational needs and emerging areas of research interest.

One finding of this research is that modern data storage capacity is creating new opportunities for analysis within a marketing context. Employers are telling us that there is a need to equip students with the technical ability to analyse large data sets and with the skills to communicate their findings. The emphasis appears to be shifting from doing things optimally to getting to best intelligence and using it in a reasonable way.

If universities decide to accept the challenges, they need to re-structure their courses away from the very detailed mathematical knowledge of how an algorithm works towards a better understanding of the opportunities that might lie hidden in our customer database. Such database is likely to be huge and not amenable to exact analysis. Perhaps we should discard from the classroom the stepping stone algorithm and immerse ourselves in the world of the approximate and fast heuristic.

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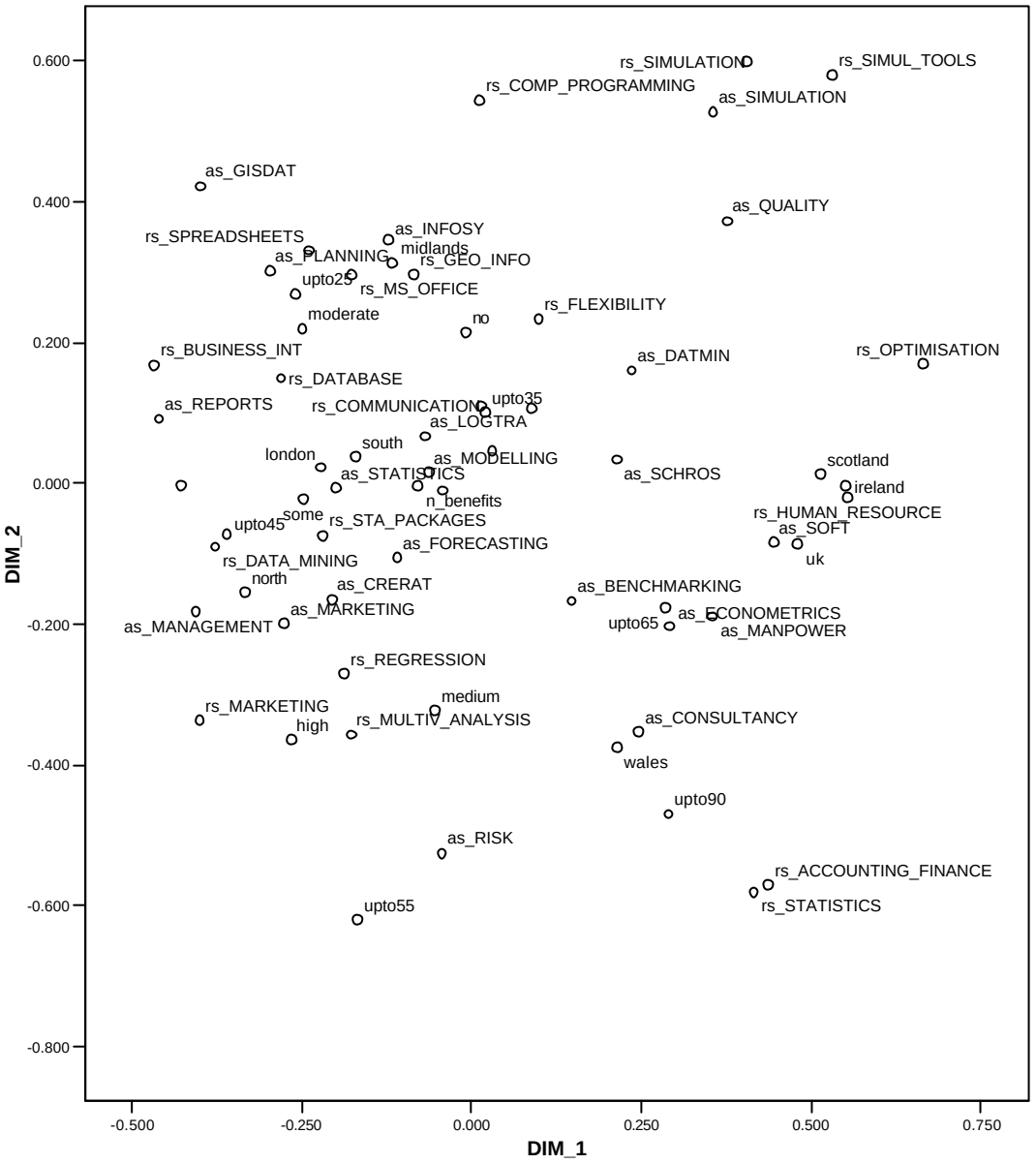

Figure 1.- Multidimensional scaling configuration. Plot of Dimension 1 and Dimension 2.

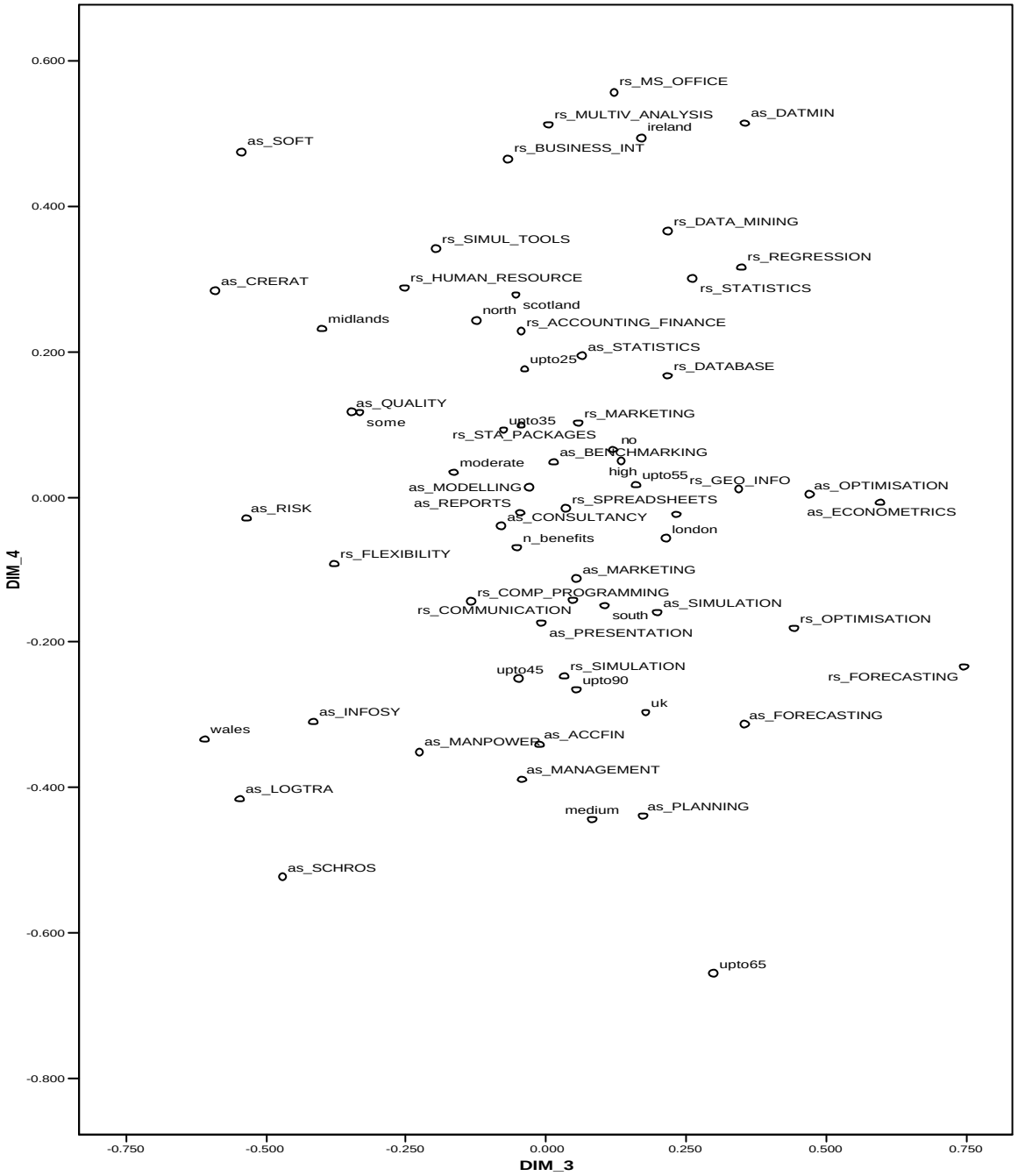

Figure 2. Multidimensional scaling configuration. Plot of Dimension 3 versus Dimension 4.

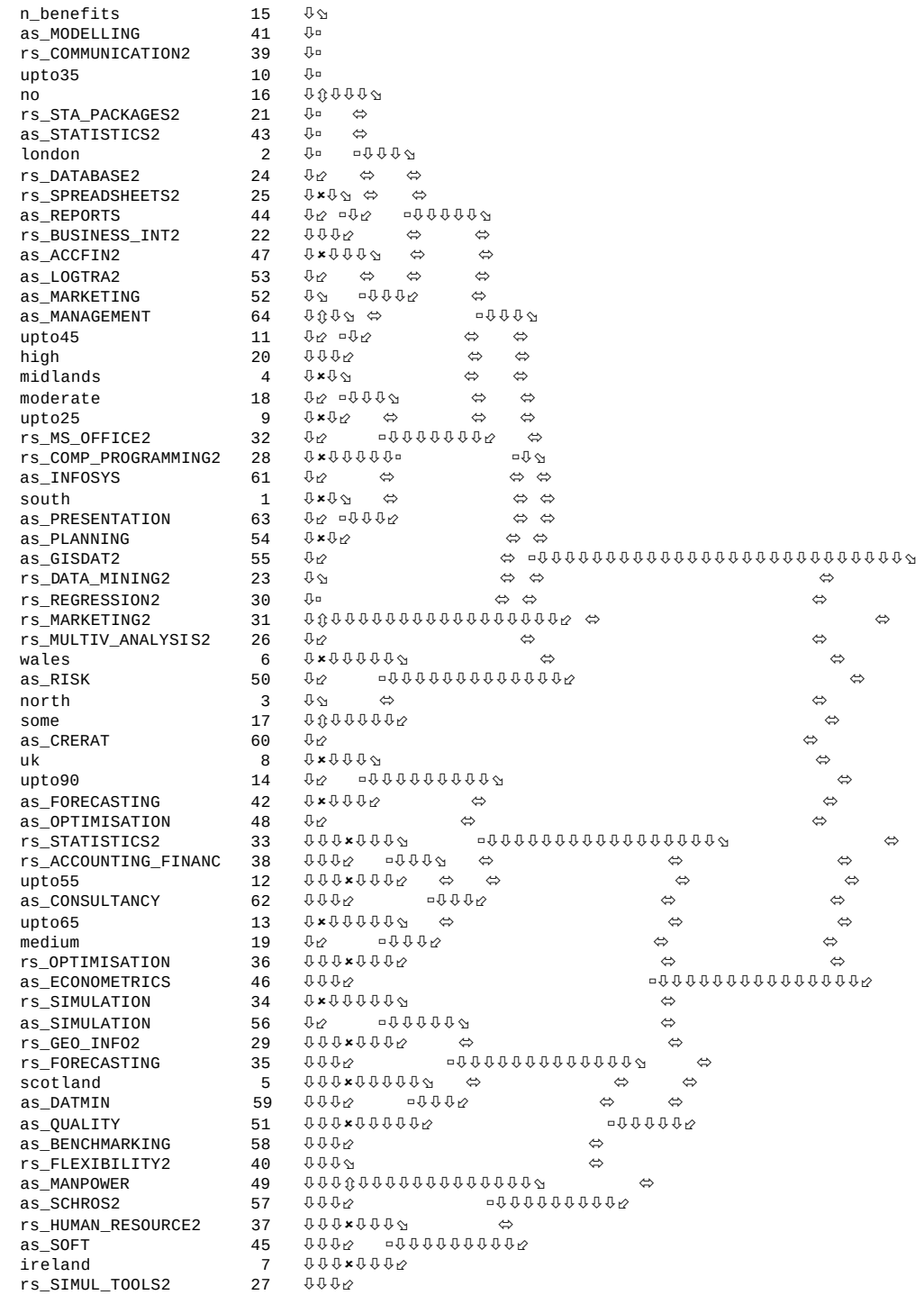

Figure 3. Dendogram using Ward's method

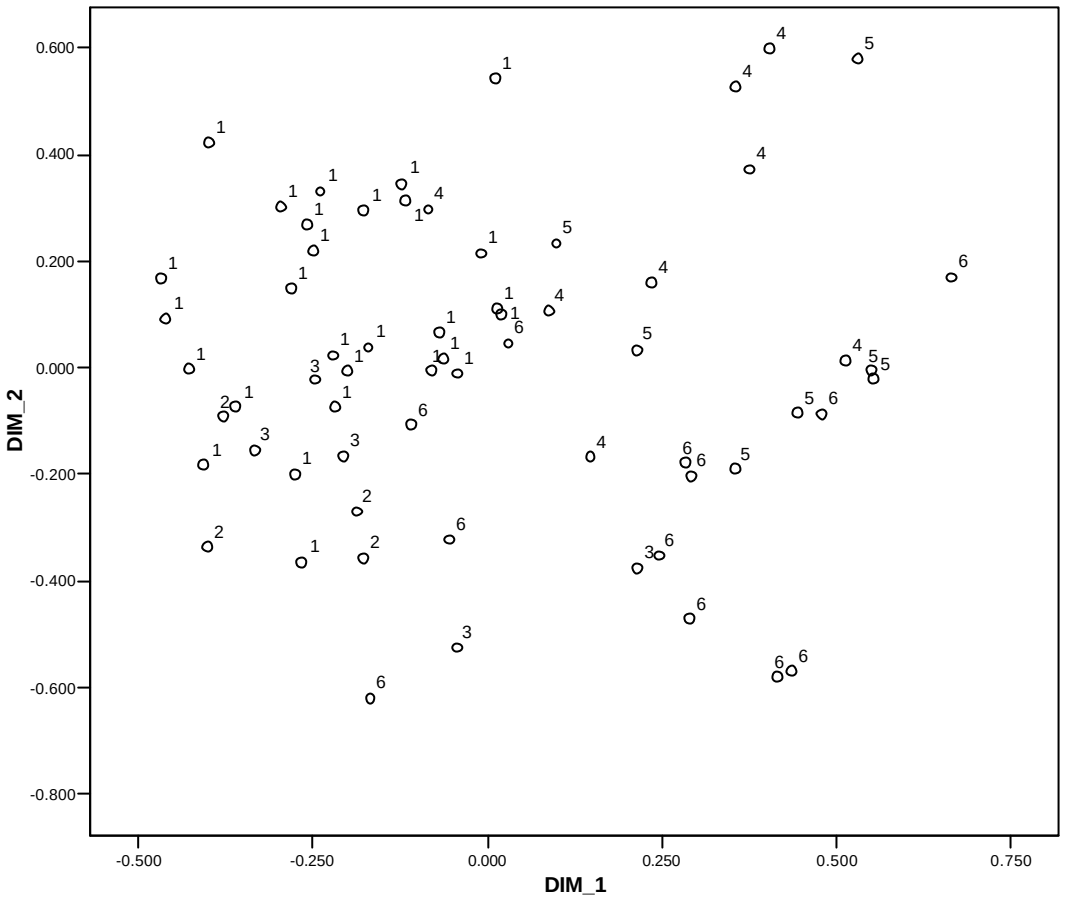

Figure 4.- Projection of the MDS configuration on Dimensions 1 and 2 showing the clusters.