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# How are Statistical Journals Linked?
# A Network Analysis

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**Abstract** - The exploratory analysis developed in this paper relies on the hypothesis that each editor possesses some power in the definition of the editorial policy of her journal. Consequently if the same scholar sits on the board of two journals, those journals could have some common elements in their editorial policies. The proximity of the editorial policies of two scientific journals can be assessed by the number of common editors sitting on their boards. A database of all editors of the journals classified as "Statistics & Probability" in the *Journal of Citation Report* by ISI-Thomson is used. The structure of the network generated by the interlocking editorship is explored applying the instruments of network analysis. Evidences are found of a very compact network. This is interpreted as the result of a common perspective about the appropriate methods for investigating the problems and constructing the theories in the domain of statistics.

**Keywords:** Networks; Journals; Editorial boards; Interlocking editorship; Statisticians
**JEL classification:** A 140

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Scientific research and its evaluation present a non-reducible social dimension (see Longino, 2006 and the bibliography cited therein). It is usual to ask a colleague to collaborate when writing a paper, commenting on a book, or revising a project. It is also usual to request the opinions of experts (or *peers*) in order to judge the quality of a paper, research results or a research project. The editorial boards of scientific journals decide which papers are worthy of publication on the basis of revision by anonymous referees. The proxies normally used for measuring the scientific quality of a paper or a journal - *e.g.* the well-known impact factor - are implicitly based on the relational dimension of the scientific activity. Indeed, bibliometric popularity depends on the number of citations received by other scholars (mainly in the same research domain). In some cases, the relevance of individual scientific activity is approximated by esteem indicators. Esteem indicators are based on the positive appraisal that other scholars attribute to an individual, and this positive appraisal is reflected in the position he or she occupies in the scientific community (for example, as the director of a research project, the editor of a scientific journal and so on).

All the scholars and activity described above can be viewed as interdependent rather than autonomous units: the scientific activity can then be considered a relational link among the scholars. The connection pattern among scholars gives rise to a social network, and its structure affects the social interactions amongst them. By adopting the concepts of graph theory, such a network may be represented as a set of vertices denoting actors joined in pairs by lines denoting acquaintance. Hence, the quantitative empirical studies in this setting may be conducted with the tools of network analysis (for an introduction to the topic see *e.g.* Wasserman and Faust, 1994).

This approach has often been applied to the analysis of networks generated by scientific activities. Probably, the most investigated topic is the network of scientific collaboration. In this case, two scientists are considered connected if they have co-authored a paper. As an example, Newman (2004) analyzed the collaboration networks of scientists in the areas of biology, medicine and physics and found some interesting properties: all these networks constitute a "small world" (Barabási, 2003) in which the average distance between scientists via intermediate collaborators is very small.

The aim of this paper is to explore the structural properties of the network generated by the editorial activities of the members in the statistical community. In this case, the vertices of the network are statistical journals and a link between a pair of journals is generated by the presence of a common editor on the board of both. Actually, this network is generated by a simple transformation of the so-called dual-mode or affiliation network. More precisely, a dual-mode network is one in which the vertices are divided into two sets (actors and events) and the affiliation connects the vertices from the two different sets only (see *e.g.* de Nooy *et al.*, 2005). In our case, affiliation (being a member of the editorial board) connects a statistician to a statistical journal. The duality specifically refers to the two alternative perspectives by which editors are linked by their affiliation to the same journal, and at the same time two journals are linked by the editors who are on their boards. Therefore, there are two different ways to view the affiliation network: as one of editors linked by journals (networks of co-membership), or as one of journals linked by editors (interlocking of events). It is possible to study the dual-mode network as a whole, or to transform the original dual-mode network into two single-mode networks focussing only on the analysis of the network of editors or of journals.

The domain of the present research is the academic community of statisticians gathered around the 81 journals included in the category "Statistics & Probability" of the 2005 edition of the *Journal of Citation Report Science Edition* managed by ISI-Thomson. By studying the structure of the statistical journal network with the tools of network analysis, we can shed some light on the underlying processes according to which research is conducted by scholars. The issues on which we focus are: which are the most central statistical journals of the network and which are the most peripheral? Which statistical journals have the most influence over others? Does the community of statisticians break down into smaller groups? If so, what are they? More in general, is it possible to separate schools of thought, methodologies or pattern of research characterizing the statistical community? And is it possible to infer anything about the functioning of the "research market" in the domain of statistics?

To the best of our knowledge, literature presents no extensive discussion of the role of editorial boards for scientific journals. But we possess anecdotal evidence and some recent tentative generalizations. Traditionally, the main function of the editorial boards was to determine which articles were appropriate for publication. In the last two or three decades this function has changed: the spread of the anonymous referee process allows editorial boards to concentrate on selecting and evaluating referees. In any case, the role of editors can be considered of relevance in guiding research in a discipline, encouraging or suppressing various directions (see *e.g.* Stigler *et al.*, 1995, and the reference therein).

From the perspective of this article, it is apparent that editorial boards have some power in shaping the editorial processes and policies of statistical journals. Therefore, this paper is based on the hypothesis that each editor may influence the editorial policy of his journal. Consequently, if the same individual sits on the board of two journals, those journals could have some common elements in their editorial policies. It is evident that we will not be concerned with direct observations of the editorial policies adopted by the boards of statistical journals. We will infer considerations about the similarity of editorial policies by observing the presence of scholars on editorial boards.

Finally, it is worth remarking that the present framework is similar to that considered in interlocking directorship analysis, which is probably the most developed field of application of dual-mode network analysis. An interlocking directorate occurs when a person sitting on the board of directors of a firm also sits on the board of another firm. Those interlocks have become primary indicators of inter-firm network ties. An inter-firm tie can be explained as the result of strategic decisions by firms, such as collusion, cooptation or monitoring environmental uncertainty sources (see Mizruchi, 1996 and the reference cited therein). Analogously, this paper deals with interlocking editorship. A brief discussion of some possible explanations of the phenomenon is presented at the conclusion of this paper.

## *The centre and periphery in the interlocking editorship network*

First, it should be emphasized that the empirical notion of editor adopted in this paper is very broad. Indeed, it covers all the individuals listed as editor, co-editor, member of the editorial board or of the advisory editorial board. There is no evidence regarding the roles of different kinds of editors in the editorial process (possibly apart from the role of editor-in-chief) and a single title such as managing editor may often entail very different roles for different journals. Hence, as in Hodgson and Rothman (1999), the broad definition is assumed.

The affiliation network database was constructed *ad hoc* for this paper. We have included in our research 79 of the 81 statistical journals present in the category "Statistics & Probability" of the

2005 edition of *Journal of Citation Report Science Edition*. The two journals excluded were *Utilitas Mathematica*, given that it has no fixed editorial board, and the *Journal of the Royal Statistical Society (Series D)*, as it ceased publication in 2003. According to common wisdom, this set of journals includes all major scientific journals in the field of statistics and probability.

The data on the members of the editorial boards was directly obtained from the website of the journals or - for the few cases when the site was unavailable - from the hard copy. The data was collected from March to July 2006 considering the boards published on the websites of the journals in that period. When the hard copy was necessary, the board considered was that of the first issue in 2006 or, alternatively, that of the last issue in 2005. Moreover, the database was managed by means of the package *Pajek* (de Nooy *et al.*, 2005).

In this database, 2,801 seats were available on the editorial boards and they were occupied by 2,091 scholars. The average number of seats per journal turned out to be 35.5, while the average number of seats occupied by each scholar (*i.e.* the mean rate of participation) was 1.3. The number of lines linking the journals is 373, and the density of the interlocking directorship network (*i.e.* the ratio of the actual number of lines to the maximum possible number of lines in the network) is 0.12. This means that 12% of the possible lines is present (for more details on the interpretation of this index see Wasserman and Faust, 1994). The graph of the network is reported in Figure 1. The vertices in the graph are automatically placed by the package *Pajek* on the basis of the Fruchterman-Reingold procedure. In this graph three main subsets may be roughly recognized: the lower part mainly presents pure and applied probability journals, the central part methodological statistical journals and the upper part applied statistical journals.

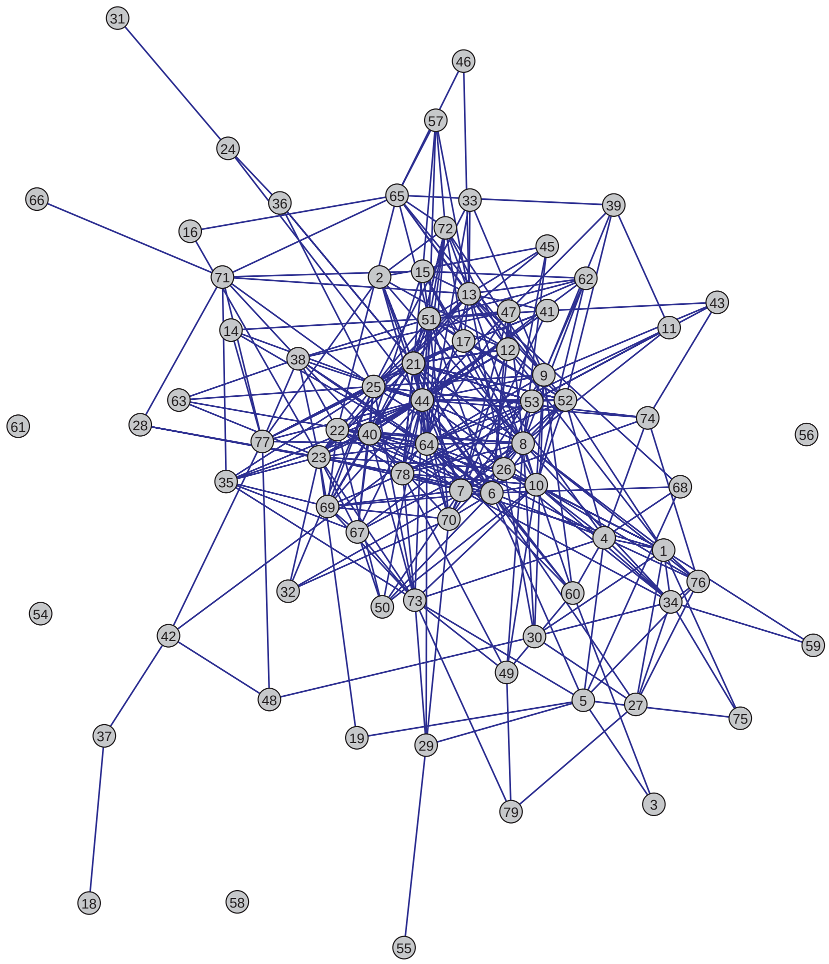


**Figure 1.** The graph corresponding to the statistical journal network (the journals are labelled according to the legend of Table II).

In order to consider an initial exploratory analysis, the degree distribution has been provided. In the present setting, the degree of a journal is the number of lines which it shares with the other journals. Table I contains the degree distribution of the journals considered. The mean degree is 9.44 (while the median degree turns out to be 8) and the degree standard deviation is 7.54. It is interesting to remark that solely four journals are isolated from the network (*i.e.* they have zero degree). They are four interdisciplinary journals with a major emphasis on other disciplines, and are edited by members of other scientific communities. More precisely, *The Oxford Bulletin of Economics and Statistics* is actually an economic journal; *Quality and Quantity* and *Multivariate Behavioral Research* are devoted to the research of social sciences, hosting many statistical papers; *Probabilistic Engineering Mechanics* is a journal dedicated to the application of probability methods to various fields of engineering. All the other journals are linked directly or indirectly, showing a strongly connected network. Indeed, the search for components in the network trivially shows four components each made up of one element (the aforementioned journals) and one big component made up of the remaining 75 journals. As usual, a component is a maximal connected sub-network, *i.e.* each pair of sub-network vertices are connected by a sequence of distinct lines (for more details see *e.g.* de Nooy *et al.*, 2005).

**Table I.** Degree frequency distribution of the statistical journals.

| Degree | Freq | Freq (%) | Degree | Freq | Freq (%) |
|---|---|---|---|---|---|
| 0 | 4 | 5.1 | 13 | 2 | 2.5 |
| 1 | 4 | 5.1 | 14 | 3 | 3.8 |
| 2 | 6 | 7.6 | 15 | 1 | 1.3 |
| 3 | 5 | 6.3 | 16 | 1 | 1.3 |
| 4 | 9 | 11.4 | 18 | 1 | 1.3 |
| 5 | 4 | 5.1 | 19 | 2 | 2.5 |
| 6 | 4 | 5.1 | 20 | 1 | 1.3 |
| 7 | 1 | 1.3 | 22 | 5 | 6.3 |
| 8 | 5 | 6.3 | 23 | 1 | 1.3 |
| 9 | 4 | 5.1 | 24 | 2 | 2.5 |
| 10 | 3 | 3.8 | 26 | 1 | 1.3 |
| 11 | 3 | 3.8 | 35 | 1 | 1.3 |
| 12 | 6 | 7.6 | | | |

A main concern in network analysis is to distinguish between the centre and the periphery of the network. In our case, the problem is to distinguish between the statistical journals which have a central position in the network and those in the periphery. As suggested by Wasserman and Faust (1994), three centrality measures for each journal in the network may be adopted. The simplest measure for the centrality of a journal is represented by its degree: indeed, the more ties a journal has to other journals, the more central its position in the network. For example, the *Journal of Statistical Planning and Inference* is linked with 35 journals, while *Statistical Modelling* is linked with solely one. Hence, the first is more central in the network than the second. In addition, the normalized degree of a journal is the ratio of its degree to the maximum possible degree (*i.e.* the number of journals minus 1). Thus, the *Journal of Statistical Planning and Inference* is linked with about 45% of the other journals in the network, while *Statistical Modelling* is linked with only 1.3%. Table II contains the degree and the normalized degree for the statistical journals considered. An overall measure of centralization in the network (based on marginal degrees) is given by so-called degree centralization (see Wasserman and Faust, 1994). In this case, the index turns out to be 0.34, showing that the network of statistical journals is quite centralized.

The second centrality measure is given by closeness centrality, which is based on the distance between a journal and all the other journals. In the network analysis, the distance between two vertices is usually based on so-called geodesic distance. Geodesic is the shortest path between two vertices, while its length is the number of lines in the geodesic (Wasserman and Faust, 1994). Hence, the closeness centrality of a journal is the number of journals (linked to this journal by a path) divided by the sum of all the distances (between the journal and the linked journals). The basic idea is that a journal is central if its board can quickly interact with all the other boards. Journals occupying a central location with respect to closeness can be very effective in communicating information (sharing research, sharing papers, deciding editorial policies) to other journals. Table II contains the closeness centrality for the statistical journals. By focussing on the connected network of 75 journals, it is possible to compute the overall closeness centrality of journals (see *e.g.* Wasserman and Faust, 1994). The overall closeness centrality is 0.35, showing in turn that the network of statistical journals is quite centralized.

**Table II.** Centrality measures and corresponding rankings of the statistical journals

| Label | Journal | Degree | Normalized degree | Normalized degree rank | Closeness | Closeness rank | Betweeness | Betweeness rank |
|---|---|---|---|---|---|---|---|---|
| 1 | Advances in Applied Probability | 13 | 0.167 | 20 | 0.426 | 35 | 0.0304 | 14 |
| 2 | American Statistician | 9 | 0.115 | 34 | 0.439 | 30 | 0.0030 | 50 |
| 3 | Annales de l'Institut Henri Poincaré | 2 | 0.026 | 66 | 0.315 | 69 | 0.0002 | 66 |
| 4 | Annals of Applied Probability | 13 | 0.167 | 20 | 0.450 | 21 | 0.0183 | 27 |
| 5 | Annals of Probability | 9 | 0.115 | 34 | 0.399 | 48 | 0.0217 | 19 |
| 6 | Annals of Statistics | 24 | 0.308 | 3 | 0.520 | 3 | 0.0506 | 6 |
| 7 | Annals of the Institute of Statistical Mathematics | 18 | 0.231 | 14 | 0.488 | 13 | 0.0177 | 28 |
| 8 | Applied Stochastics Models in Business and Industry | 24 | 0.308 | 3 | 0.520 | 3 | 0.0591 | 5 |
| 9 | Australian & New Zealand Journal of Statistics | 15 | 0.192 | 16 | 0.488 | 13 | 0.0327 | 12 |
| 10 | Bernoulli | 19 | 0.244 | 12 | 0.502 | 11 | 0.0352 | 10 |
| 11 | Bioinformatics | 4 | 0.051 | 52 | 0.392 | 51 | 0.0017 | 54 |
| 12 | Biometrical Journal | 14 | 0.179 | 17 | 0.465 | 17 | 0.0120 | 32 |
| 13 | Biometrics | 22 | 0.282 | 6 | 0.505 | 10 | 0.0619 | 4 |
| 14 | Biometrika | 4 | 0.051 | 52 | 0.401 | 45 | 0.0001 | 67 |
| 15 | Biostatistics | 9 | 0.115 | 34 | 0.426 | 35 | 0.0073 | 36 |
| 16 | British Journal of Mathematical and Statistical Psychology | 2 | 0.026 | 66 | 0.350 | 64 | 0.0003 | 64 |
| 17 | Canadian Journal of Statistics | 10 | 0.128 | 31 | 0.445 | 28 | 0.0032 | 48 |
| 18 | Chemometrics and Intelligent Laboratory Systems | 1 | 0.013 | 72 | 0.211 | 75 | 0.0000 | 70 |
| 19 | Combinatorics, Probability & Computing | 2 | 0.026 | 66 | 0.353 | 63 | 0.0009 | 58 |
| 20 | Communications in Statistics. Theory and Methods | 22 | 0.282 | 6 | 0.517 | 5 | 0.0214 | 20 |
| 21 | Communications in Statistics. Simulation and Computation | 22 | 0.282 | 6 | 0.517 | 5 | 0.0214 | 20 |
| 22 | Computational Statistics | 12 | 0.154 | 22 | 0.471 | 16 | 0.0063 | 37 |
| 23 | Computational Statistics & Data Analysis | 22 | 0.282 | 6 | 0.502 | 11 | 0.0651 | 3 |
| 24 | Econometrica | 3 | 0.038 | 61 | 0.370 | 58 | 0.0246 | 17 |
| 25 | Environmental and Ecological Statistics | 20 | 0.256 | 11 | 0.509 | 8 | 0.0491 | 8 |
| 26 | Environmetrics | 12 | 0.154 | 22 | 0.447 | 26 | 0.0196 | 25 |
| 27 | Finance and Stochastics | 6 | 0.077 | 44 | 0.376 | 54 | 0.0053 | 41 |
| 28 | Fuzzy Sets and Systems | 3 | 0.038 | 61 | 0.366 | 61 | 0.0008 | 60 |
| 29 | Infinite Dimensional Analysis, Quantum Probability and Related Topics | 5 | 0.064 | 48 | 0.397 | 49 | 0.0262 | 16 |
| 30 | Insurance: Mathematics and Economics | 7 | 0.090 | 43 | 0.411 | 41 | 0.0117 | 33 |
| 31 | International Journal of Game Theory | 1 | 0.013 | 72 | 0.267 | 74 | 0.0000 | 70 |
| 32 | International Statistical Review | 4 | 0.051 | 52 | 0.384 | 53 | 0.0007 | 61 |
| 33 | Journal of Agricultural Biological and Environmental Statistics | 4 | 0.051 | 52 | 0.411 | 41 | 0.0001 | 69 |
| 34 | Journal of Applied Probability | 11 | 0.141 | 30 | 0.413 | 40 | 0.0199 | 24 |
| 35 | Journal of Applied Statistics | 8 | 0.103 | 38 | 0.428 | 33 | 0.0034 | 46 |
| 36 | Journal of Business and Economic Statistics | 4 | 0.051 | 52 | 0.370 | 58 | 0.0024 | 51 |
| 37 | Journal of Chemometrics | 2 | 0.026 | 66 | 0.270 | 73 | 0.0243 | 18 |
| 38 | Journal of Computational and Graphical Statistics | 11 | 0.141 | 28 | 0.450 | 21 | 0.0110 | 34 |
| 39 | Journal of Computational Biology | 5 | 0.064 | 48 | 0.372 | 56 | 0.0021 | 53 |
| 40 | Journal of Multivariate Analysis | 22 | 0.282 | 6 | 0.509 | 8 | 0.0209 | 23 |
| 41 | Journal of Nonparametric Statistics | 8 | 0.103 | 38 | 0.416 | 38 | 0.0044 | 44 |
| 42 | Journal of Quality Technology | 4 | 0.051 | 52 | 0.372 | 56 | 0.0496 | 7 |
| 43 | Journal of Statistical Computation and Simulation | 4 | 0.051 | 52 | 0.355 | 62 | 0.0009 | 59 |
| 44 | Journal of Statistical Planning and Inference | 35 | 0.449 | 1 | 0.581 | 1 | 0.1191 | 1 |
| 45 | Journal of the American Statistical Association | 5 | 0.064 | 48 | 0.397 | 49 | 0.0005 | 62 |
| 46 | Journal of the Royal Statistical Society, Series A | 2 | 0.026 | 66 | 0.338 | 65 | 0.0000 | 70 |
| 47 | Journal of the Royal Statistical Society, Series B | 10 | 0.128 | 31 | 0.436 | 31 | 0.0050 | 42 |
| 48 | Journal of the Royal Statistical Society, Series C | 3 | 0.038 | 61 | 0.338 | 65 | 0.0031 | 49 |
| 49 | Journal of Theoretical Probability | 6 | 0.077 | 44 | 0.392 | 51 | 0.0047 | 43 |
| 50 | Journal of Time Series Analysis | 6 | 0.077 | 44 | 0.401 | 45 | 0.0004 | 63 |
| 51 | Lifetime Data Analysis | 23 | 0.295 | 5 | 0.513 | 7 | 0.0292 | 15 |
| 52 | Methodology and Computing in Applied Probability | 16 | 0.205 | 15 | 0.465 | 17 | 0.0144 | 30 |
| 53 | Metrika | 12 | 0.154 | 22 | 0.450 | 21 | 0.0109 | 35 |
| 54 | Multivariate Behavioral Research | 0 | 0.000 | 76 | 0.000 | 76 | 0.0000 | 70 |
| 55 | Open Systems & Information Dynamics | 1 | 0.013 | 72 | 0.281 | 72 | 0.0000 | 70 |
| 56 | Oxford Bulletin of Economics and Statistics | 0 | 0.000 | 76 | 0.000 | 76 | 0.0000 | 70 |
| 57 | Pharmaceutical Statistics | 5 | 0.064 | 48 | 0.368 | 60 | 0.0003 | 65 |
| 58 | Probabilistic Engineering Mechanics | 0 | 0.000 | 76 | 0.000 | 76 | 0.0000 | 70 |
| 59 | Probability in the Engineering and Informational Sciences | 2 | 0.026 | 66 | 0.296 | 70 | 0.0000 | 70 |
| 60 | Probability Theory and Related Fields | 8 | 0.103 | 38 | 0.436 | 31 | 0.0189 | 26 |
| 61 | Quality and Quantity | 0 | 0.000 | 76 | 0.000 | 76 | 0.0000 | 70 |
| 62 | Scandinavian Journal of Statistics | 8 | 0.103 | 38 | 0.428 | 33 | 0.0014 | 55 |
| 63 | Statistica Neerlandica | 4 | 0.051 | 52 | 0.374 | 55 | 0.0001 | 68 |
| 64 | Statistica Sinica | 26 | 0.333 | 2 | 0.549 | 2 | 0.1154 | 2 |
| 65 | Statistical Methods in Medical Research | 11 | 0.141 | 28 | 0.416 | 38 | 0.0177 | 29 |
| 66 | Statistical Modelling | 1 | 0.013 | 72 | 0.287 | 71 | 0.0000 | 70 |
| 67 | Statistical Papers | 10 | 0.128 | 31 | 0.447 | 26 | 0.0035 | 45 |
| 68 | Statistical Science | 4 | 0.051 | 52 | 0.401 | 45 | 0.0022 | 52 |
| 69 | Statistics | 14 | 0.179 | 17 | 0.456 | 20 | 0.0032 | 47 |
| 70 | Statistics & Probability Letters | 12 | 0.154 | 22 | 0.450 | 21 | 0.0136 | 31 |
| 71 | Statistics and Computing | 9 | 0.115 | 34 | 0.408 | 43 | 0.0324 | 13 |
| 72 | Statistics in Medicine | 12 | 0.154 | 22 | 0.450 | 21 | 0.0057 | 39 |
| 73 | Stochastic Analysis and Applications | 14 | 0.179 | 17 | 0.465 | 17 | 0.0375 | 9 |
| 74 | Stochastic Environmental Research and Risk Assessment | 6 | 0.077 | 44 | 0.418 | 37 | 0.0062 | 38 |
| 75 | Stochastic Models | 3 | 0.038 | 61 | 0.316 | 68 | 0.0011 | 56 |
| 76 | Stochastic Processes and their Applications | 8 | 0.103 | 38 | 0.404 | 44 | 0.0055 | 40 |
| 77 | Technometrics | 12 | 0.154 | 22 | 0.445 | 28 | 0.0343 | 11 |
| 78 | Test | 19 | 0.244 | 12 | 0.488 | 13 | 0.0213 | 22 |
| 79 | Theory of Probability and its Applications | 3 | 0.038 | 61 | 0.335 | 67 | 0.0010 | 57 |

The third considered measure is the so-called betweeness centrality. The idea behind the index is that similar editorial aims between two non-adjacent journals might depend on other journals in the network, especially on those journals lying on the paths between the two. The other journals potentially might have some control over the interaction between two non-adjacent journals. Hence, a journal is more central in this respect if it is an important intermediary in links between other journals. From a formal perspective, the betweeness centrality of a journal is the proportion of all paths between pairs of other journals that include this journal. Table II contains the betweeness centrality of the statistical journals. For example, the *Journal of Statistical Planning and Inference* and *Statistica Sinica* are each in about 12% of the paths linking all other journals in the network. In turn, it is possible to compute the overall betweeness centralization of the network (Wasserman and Faust, 1994). In this case, the overall betweeness centralization is 0.10.

It is worth noting the ranking similarity of the three centrality measures. This item is emphasized by the high value of Kendall's concordance index which equals 0.90 (for more details on Kendall's concordance index see *e.g.* Gibbons and Chakraborti, 1992).

By focussing attention on the first positions in the journal ranking according to the degree centrality and closeness centrality rankings, it is at once apparent that they are occupied by the same journals. Moreover, the top four journals in these two rankings are the same and in the same order: *Journal of Statistical Planning and Inference*, *Statistica sinica*, *Annals of Statistics*, and *Applied Stochastics Models in Business and Industry*. The *Journal of Statistical Planning and Inference*, *Statistica sinica* and the *Annals of Statistics* are broad-based journals aiming to cover all branches of statistics. On the contrary, *Applied Stochastic Models in Business and Industry* publishes papers on the interface between stochastic modeling, data analysis and their applications in business and finance. The central position of this journal may be explained by its interdisciplinary nature, *i.e.* by the presence of many influential editors who give rise to a large number of different links with the other journals. These four journals also display a top ranking even if the betweeness centrality is considered.

*Computational Statistics & Data Analysis* and *Biometrics* are also central in the network. *Computational Statistics & Data Analysis* publishes papers on different topic in statistics, with a great emphasis on computational methods and data analysis, while *Biometrics* promotes general statistical methodology with applications for biological and environmental data. In addition, *Communications in Statistics (Theory and Methods), Communications in Statistics (Simulation and Computation),* the *Journal of Multivariate Analysis* and *Lifetime Data Analysis* are important in sustaining the network structure even if their role in connecting the other journals in the network is weaker since they have smaller values of betweeness centrality. In turn, the *Communications in Statistics* journals publish papers which are devoted to all the main areas of statistics. On the contrary, the *Journal of Multivariate Analysis* and *Lifetime Data Analysis* display a higher degree of specialization, since the first obviously aims to publish papers on multivariate statistical methodology, while the second generally considers applications of statistical science in the various fields dealing with lifetime data. Finally, *Environmental and Ecological Statistics* - which is obviously devoted to a rather special topic - occupies a very central position in the network. This might be due to the increasing importance of environmental research in science.

All these aforementioned journals have a long standing in statistical research and hence their role in the network is quite understandable. Obviously, the less central position of very influential journals does not reduce their importance for statistical research: this simply emphasizes that the editorial policy of the boards is different. As an example, the *Journal of the American Statistical Association* or the *Journal of the Royal Statistical Society, Series B,* have very small boards in such a way that the number of links with the other journals is moderate.

## *Valued network analysis*

It is interesting to consider the strength of the relation between journals. The network of journals can be characterized as a valued network. More precisely, in a valued network the lines have a value indicating the strength of the tie linking two vertices (Wasserman and Faust, 1994). In our case the value of the line is the number of editors sitting on the board of the two journals linked by that line.

Table III shows the distribution of journals according to their line values. As we already know there are four isolated journals and one pair of journals sharing all 83 editors, *i.e. Communications in Statistics (Theory and Methods)* and *Communications in Statistics (Simulation and Computation)* . This last case is completely similar to that of the *Journal of Applied Probability* and *Advanced in Applied Probability* sharing all 25 editors. According to Table III, 65.4% of the links are generated by journals sharing only one editor and about 91% are generated by journals sharing three or less editors.

**Table III.** Line multiplicity frequency distribution.

| Line value | Freq | Freq (%) |
|---|---|---|
| 1 | 244 | 65.4 |
| 2 | 68 | 18.2 |
| 3 | 27 | 7.0 |
| 4 | 12 | 3.2 |
| 5 | 10 | 2.7 |
| 6 | 5 | 1.3 |
| 7 | 2 | 0.5 |
| 9 | 1 | 0.3 |
| 10 | 3 | 0.8 |
| 25 | 1 | 0.3 |
| 83 | 1 | 0.3 |

In social network analysis it is usual to consider lines with higher value to be more important since they are less personal and more institutional (de Nooy *et al.*, 2005). In the case of the journal network, the basic idea is very simple: the editorial proximity between two journals can be measured by observing the degree of overlap among their boards. Two journals with no common editors have no editorial relationship. Two journals with the same board share the same aim, *i.e.* the two journals have a common or, at least shared, editorial policy. As an example, *Statistica Sinica* (the Chinese statistical journal) and *Quality and Quantity* (an Italian sociological journal), have no common editors, so that their editorial policies can be considered independent of each other. The opposite situation occurs with *Communications in Statistics (Theory and Methods)* and *Communications in Statistics (Simulation and Computation)*. These two journals share all 83 board members and their editorial policies are complementary: theoretical contributions are addressed by the former, applied contributions by the latter. Obviously, there are different degrees of integration between these two extreme cases. Actually, two journals sharing solely one member of their boards are less linked than two journals sharing two or more editors.

Starting from this basis it is possible to define cohesive subgroups, *i.e.* subsets of journals among which there are relatively strong ties. In a valued network a cohesive subgroup is a subset of vertices among which ties have a value higher than a given threshold. In our case, a cohesive subgroup of journals is a set of journals sharing a number of editors equal or higher than the threshold. In our interpretation, a cohesive subgroup of journals is a subgroup with a similar editorial policy, belonging to the same subfield of the discipline or sharing a common methodological approach. Following de Nooy *et al.* (2005), cohesive subgroups are identified as weak components in *m*-slices, *i.e.* subsets for which the threshold value is at least *m*.

As previously remarked, the network of statistical journals is compact: with the exception of the four isolated journals, it is possible to reach a given journal starting from any other journal. The search for cohesive subgroups shows a clear path: the presence of a relatively big component and the complete fragmentation of the others in small groups mostly including solely one journal, or by very small groups with niche specialization. Figure 2 contains the representation of the central component of the network identified as a weak component in 4-slices. The 21 journals in this subset of the network have at least 4 common editors. The dimension of each vertex represents the betweeness centrality of the corresponding journal.

The centre of the big component is the *Journal of Statistical Planning and Inference* since it controls the links with most of the other journals. By dropping this journal from the network, two journals are isolated and four groups of journals belonging to different branches of statistics emerge. *Statistica Sinica* is the bridge connecting the set of statistical journals dealing with applications to biology and medicine (*i.e. Biometrics*, *Statistical in Medicine*, *Statistical Methods in Medical Research*, *Lifetime Data Analysis* and *Biostatistics*). It is worth noting that *Biometrics* is central in maintaining this subset.

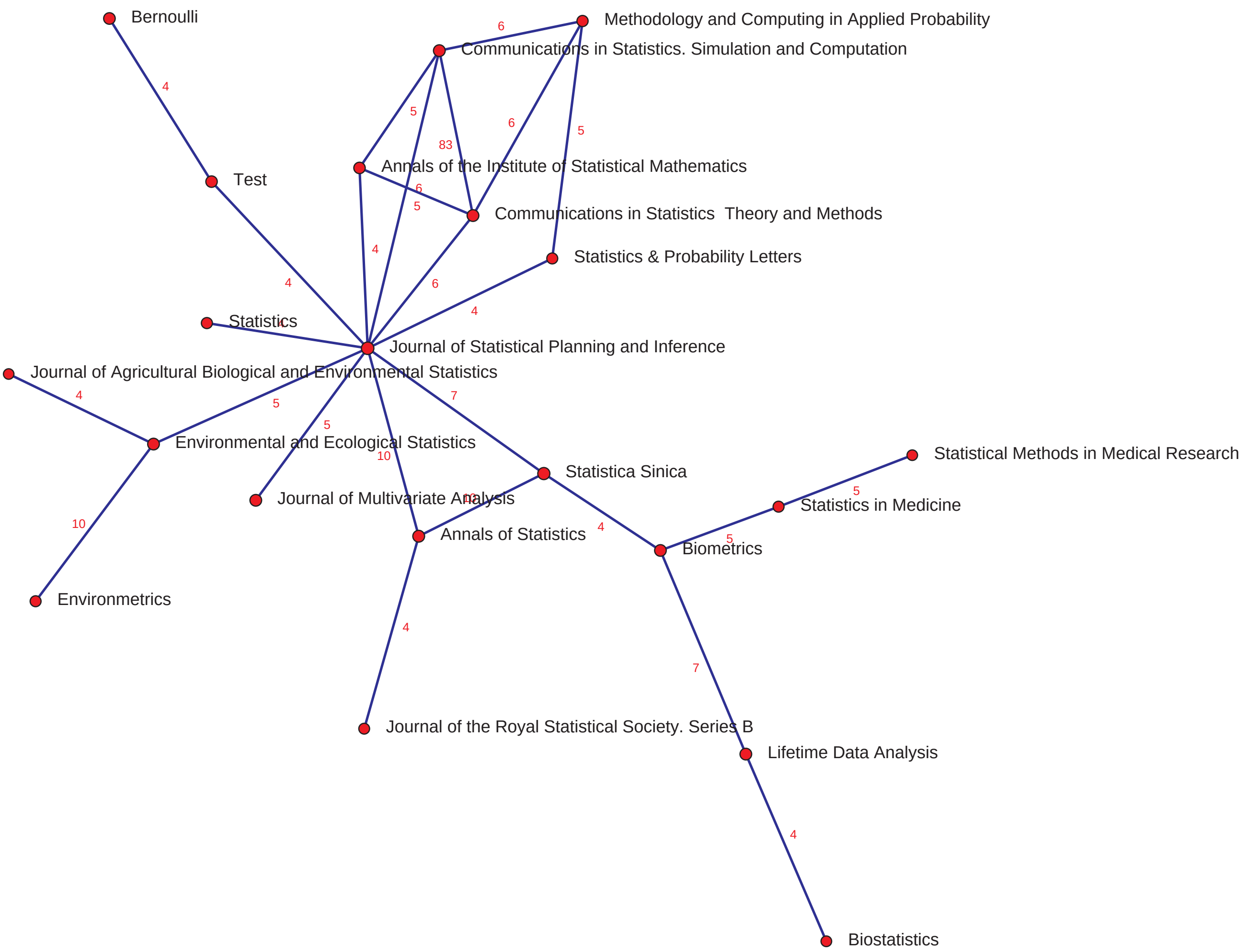


**Figure 2.** Big weak component in 4-slices network
(the dimension of vertices is proportional to betweeness centrality).

The *Annals of Statistics* and the *Journal of the Royal Statistical Journal, Series B* represent the subgroup of journals publishing high-quality papers in the area of mathematical statistics. *Environmental and Ecological Statistics* is the bridge toward the other journals devoted to environmental statistics, *i.e. Environmetrics* and the *Journal of Agricultural Biological and Environmental Statistics*.

The subgroup of five journals in the upper right part of Figure 2, *i.e. Communications in Statistics (Theory and Methods)*, *Communications in Statistics (Simulation and Computation)*, *Annals of the Institute of Statistical Mathematics*, *Statistics & Probability Letters* and *Methodology and Computing in Applied Probability* may be interpreted as the subset building in some sense a bridge between mathematical statistics and probability. Finally, *Test* and *Bernoulli* constitute the subgroup devoting attention to rather technical papers (in some cases with special emphasis on Bayesian methodology).

The other six small groups of journals with niche specialization resulting from the search of cohesive subgroups are reported in Figure 3. There are five components given by pairs of journals motivated by specialized aims and one component given by four journals of computational statistics. Four smaller components deal with different areas of probability, *i.e.* pure probability, applied probability, probability in finance and probability in physics. The remaining small component represents the journals concerning computational statistics and publishing statistical papers connected to this topic.

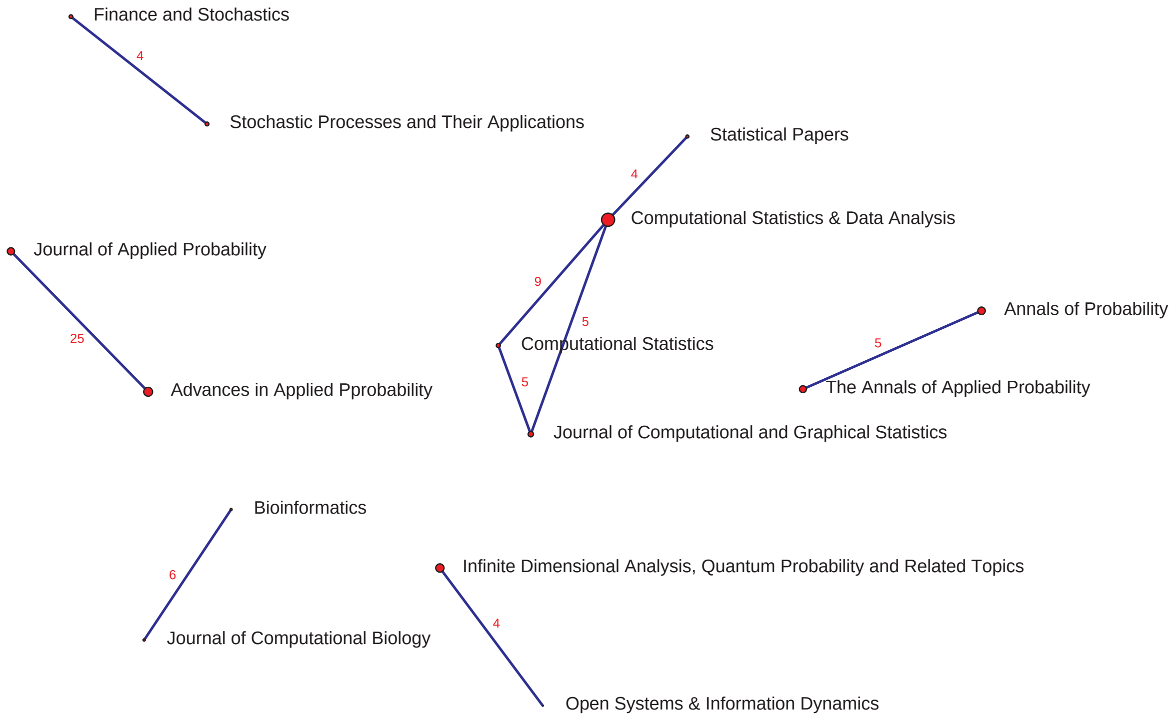


**Figure 3.** Small weak components in 4-slices network.

## *Conclusive remarks*

The exploratory analysis developed in this paper relies on a weak hypothesis: each editor possesses some power in the definition of the editorial policy of his journal. Consequently, if the same scholar sits on the board of two journals, those journals could have some common elements in their editorial policies. The proximity of the editorial policies of two scientific journals can be assessed by the number of common editors sitting on their boards. On the basis of this statement, applying the instruments of network analysis, a simple interpretation of the statistical journal network has been given.

The network generated by interlocking editorship seems to be very compact. This is probably the result of a common perspective about the appropriate methods (for investigating the problems and constructing the theories) in the domain of statistics. Competing visions or approaches to the statistical research do not prompt scholars to abandon a common tradition, a common language and a common vision about the correct view of how to conduct research. Moreover, it is not surprising that in the centre of the network lie general journals or journals devoted to the recent and growing subfields of the discipline (such as environmental statistics or biological statistics).

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