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Weight for citations or weights for numerousness?

Evaluating Italy's academic economists.

Abstract

The aim of this paper is to offer a contribution to the work of analysing which bibliometric indicators are best suited to the functions they could be expected to perform with the ongoing reform of the Italian university system. We will compare two pictures representing Italian economists as a whole on the basis of the Cineca 2007 data, using two indexes deriving from two different approaches. The first approach is based on the idea that the quality of research is to be measured in terms of its 'impact' on the scientific community, and that the impact can in turn be gauged by the number of citations. The second approach, by contrast, takes reference from the weight to be attributed – by the evaluators – to products of research, on the basis of characteristics (place and publication typology) from which are derived weighted numerousness indexes (the number of publications weighted in terms of their 'importance'). The former index, *h*, attributes importance to the quantity of citations of research products corrected on the basis of the number of publications, while the latter, *EconlitNumber*, attaches importance to the numerousness of publications corrected on the basis of the weight attributed to them. Comparing the results obtained calculating the two indexes of Italian economists, we demonstrate that they give rise to strikingly different rankings of individuals, Universities and Faculties, and are therefore to be approached very gingerly.

Codici JEL: A13. I2

Key words: evaluation, bibliometric indicators, Italian economists

1. Introduction: two approaches to evaluation[1]

The reform of the Italian university system now being implemented contains, in the mechanisms for evaluation of the quality of academic research, the linchpin for the changes that are to be brought about in Italy. For the purposes of selection – competitive examinations, research projects, assignment of resources in general – the uses of bibliometric indicators to measure scientific production is receiving consensus,[2] albeit in the context of a debate that sees a wide range of positions that are far from concurring.[3] The aim of this paper is to offer a contribution to analysis of which bibliometric indicators are best suited to the situation in Italy, considering two broad pictures of the economic disciplines painted in the light of two indexes, themselves the product of two different approaches.

The first is based on the idea that the quality of research is to be measured by its 'impact' in the scientific community and that this, in turn, is to be measured by the number of citations. In most cases measurement of impact is in terms of the numerousness of citations of the journal where the article is published. The most famous example is the *Impact Factor*[4] which, as readers will probably know, was formulated by the ISI (Institute for Scientific Information) *Web of Science*, initially as indicator of the importance of the journal for library purchase decisions, but subsequently to

[1] We wish to express our gratitude for comments and suggestions to Alberto Baccini, Adriano Birolo, Carlo d'Ippoliti, Annalisa Rosselli, Giordano Sivini, Patrizia Tiberi Vipraio, the participants in a workshop held at the University of Modena and Udine, and a workshop organised by the Storia dell'Economia Politica (STOREP) at Alessandria, where earlier drafts of this paper were presented. The comments and suggestions of an anonymous referee have proved particularly useful.

[2] The CUN has requested that in the coming CIVR five-year research evaluation programme (2004-2008) "peer review evaluation of a selected number of products should be accompanied by bibliometric indexes recognised at international level, also making use of appropriate databases, where possible uniform at the national level" (CUN Telematic Bulletin, n. 42 – 5 and 6 May 2009). Actually, the VQR 2004-2008 guidelines make no explicit reference to bibliometric indicators, simply pointing out "two methodologies: a) analysis of citations (where applicable), made directly by each Panel, using for the purpose databases agreed upon with the CIVR; b) peer review by external experts chosen collectively by the Panel (normally no more than two), whose task it is to provide anonymous comment on the quality of the publications selected". http://www.civr.miur.it/vqr_decreto.html

[3] See "The open letter on evaluation of research in the economic disciplines", signed by a group of Italian economists (by 24-05-09 it had received 128 signatures), expressing dissent over "research evaluation systems based on indirect indicators, evaluating individual contributions to research on the basis of the journal in which they are published." http://www.letteraapertavalutazionericerca.it/

[4] The *Impact Factor* is calculated thus: for example, IF 2009 for a given journal is the ratio between the number of citations received in 2009 and the number of articles published by the journal in the previous two years (2007 and 2008).

become (especially in the biomedical disciplines) progressively also a measure of the quality of research products. Recently, however, thanks to the arrival on the scene of search engines like *Google Scholar*, able to track down citations rapidly, the possibility is now at hand to calculate the impact of individual articles, with the constraint, of course, of the citations actually present in the underlying database. It was, for example, the criterion of quality measured by impact that guided the choice of products to be sent to the CIVR in the Italian University assessment programme 2001-2003, mainly of articles published in journals with a high *Impact Factor*.[5]

The second approach, on the other hand, makes reference to the weights to be attributed by the evaluators to the individual products of research, on the basis of certain characteristics (place and publication typology), from which weighted indexes of numerousness (number of publications, weighted according to their 'importance') are drawn for individuals or academic aggregations. The difficulty is, of course, to come to some agreement on which and how many weights are to be attributed (for example, number of co-authors, number of pages, whether the article was published in the journal or in a book of collected articles, etc.); although the possibility is not ruled out of using impact indicators like the numerousness of citations, this approach does not determine the 'quality' of a product or journal solely on the basis of the citations received.

We may take as an example of weighted numerousness the CUN proposal[6] of 'minimum requisites' for admission to the various levels of the academic career: it identifies the number of publications, how many must satisfy the requisite of "having been published in journals having considerable scientific importance", how many "of international standing" and with "publishers who make transparent, documented use of the services of anonymous, independent referees", and with the constraint of having been produced within a set interval of time[7]. However, the requisites of

[5] The Chairman of Panel 13, Franco Peracchi, had this comment to make on the results: "On average, the papers in journals with IF receive higher evaluations, the chapters in a book lower evaluations. It can be demonstrated that, for papers in journals with IF the probability of receiving a judgement of "Good" or "Excellent" grows with the IF of the journal". http://www.lavoce.info/dossier/pagina2173.html. For an analysis of the CIVR evaluation procedure see Corsi-D'Ippoliti and Lucidi 2010.

[6] http://www.scribd.com/doc/9698886/Requisiti-Minimi-CUN-26-Dic-2008.

[7] Within area 13 these constraints are, for researchers, at least 1-2 publications in the last 3 years (according to the date of award of doctorate), for associated professors at least 6 in the last five years, and for full professors at least 10 in the last eight years. As regards the context of publication constraint -"journals of considerable scientific importance" and,

"considerable scientific importance" and "international standing" for the journal are not defined. These criteria leave discretional margins open, and apparently attest to a failure to reach consensus on the way to measure the "importance" of a journal, the classification at present available having been constructed on different criteria producing non-convergent rankings[8].

Similarly, for evaluation of publications the VQR 2004-2008 guidelines make reference "to analysis of the citations (where applicable), conducted directly by each Panel, using to this end the databases agreed upon with the CIVR", but fail to specify the method to calculate the numerousness of citations and how to apply it (whether to the publication itself or where it appears).

These examples offer elegant evidence of the expediency of discussing the issue starting from a preliminary knowledge of the data regarding the relevant population, and of the limitations and advantages of adopting a bibliometric index or some other and comparing the results. Such is the purpose of the present paper: we will make use of two databases, *Econlit* and *Google Scholar*, to describe the characteristics of Italy's academic economists, and we will use two indicators to evaluate their scientific production: the *h* index created by Jorge E. Hirsh in 2005 and the *EconlitNumber*, an index of weighted numerousness constructed by ourselves (Marcuzzo-Zacchia 2007). Both measure quality, but on the basis of two different approaches: the first, *h* index, attributes importance to the numerousness of citations of research products, adjusted according to the number of products themselves. The second, *EconlitNumber*, attributes importance to the numerousness of publications, adjusted according to the weights ascribed to them.

In section 2 we search the two databases, *Econlit* and *Google Scholar*, for data on the numerousness of publications, supplemented with search in *Google Libri*; in section 3 we compare the two indexes, *h* and *Econlit*, while section 4 sets out some findings and on the evaluation of individual production and construction of the ranking of structures, i.e. Faculties and Departments. In the final section we set out our conclusions.

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among these, those of "international standing"- the numbers are: for associated professor (2.1) and for full professor (4. 2).

[8] For an extensive review of the literature, see Baccini 2010.

2. "Italy's academic economists according to *Econlit* and *Google Scholar*"

The first step in our investigation is to survey how much and what has been published; as will be seen, these apparently simple data are influenced by the database consulted. We will begin, then, by describing the scientific production of the today's academic economists making use of two different databases: *Econlit* and *Google Scholar*.

The universes for analysis are the permanent staff of full professors, associate professors and researchers as of 31/01/2007[9] in the scientific discipline sectors SECS-P/01-SECS-P/06 according to the Cineca-MIUR database. In all there are 1606 economists, including 43.8% full professors, 28.7% associate professors and 27.5% researchers. Women account for only 25.4% of the universe: 13.1% full professors, 27.2% associate professors and 41.5% researchers.

Econlit is one of the most complete databases used in the economic field, bringing together papers published in journals, dissertations, monographic studies, proceedings of conferences and working papers regarding all the fields of economic research. It offers wide geographical coverage (for the journals 65 countries are represented), an ample time to span (starting from 1969) and it is updated on a monthly basis. For our data-processing we drew on the *Econlit* database for July 2007, a year in which 1215 journals were represented, including 46 Italian publications.

Google Scholar is a search engine that can be used to identify texts of various types including articles, graduate and doctorate theses, books, reviews and working papers[10] in all the sectors of

[9] We used data updated to 2007 (for academic economists the Cineca Miur updated to 31/01/2007 and for publications the Econlit database consulted between February/April 2007). The choice of the universe of Italian academic economists on permanent staff as of 31/01/2007 was dictated by the need for continuity with the previous work (see Marcuzzo, Zacchia 2007), but the universe has so far remained essentially unchanged. The academics on permanent staff as of 31/12/2009 had increased by about 7%; the distribution between positions was practically the same, the largest group represented by full professors (40.5%) followed by researchers (33.5%) and, finally, associated professors (26%). However, there was a considerable increase in the number of researchers as compared with full and associate professors. There were 1526 identical names in the two versions of the CINECA database (2007 and 2009) accounting for 88% of the universe as a of 31/12/2009. Of the 202 new names present in 2009, 80.2% were researchers. On the other hand, 80 names were present in 2007 but no longer in 2009, most of these (43.4%) being full professors no longer active.

[10] Actually, the coverage of working papers (May 2010) was limited to 267 series, mainly American. For Italy were entered only those of Sant'Anna and the University of Trento. *REPEC* entered 2407.

scientific research. Since 2004 – the year when the two information technology engineers Alex Verstak and Anurag Acharya launched *Google Scholar*, this search engine has, with the agreement of the publishers, been providing links to the entire texts of scientific articles in a vast number of publications and disciplines. For each single text, the number of citations received is calculated and access is provided to the series of texts containing the citations. Despite the limitations of the algorithm (see Noruzi, 2005) and coverage (the search engine can only recognise digitalised texts), *Google Scholar* today stands as one of the richest databases in terms of citations, albeit not totally reliable; for example, titles and citations are occasionally to be found in *Google Libri* that do not appear in *Google Scholar*[11].

To ensure that the records deriving from the two databases be comparable, we consulted *Google Scholar* through the *Publish and Perish* program (freeware available on the web in 2006, programmed by Anne Will Harzing of the University of Melbourne), which enables users to delimit the time span of research and narrow down the discipline area. For our purposes we drew on data limited to the areas of Business, Administration, Finance and Economics (which we will call BAFE) together with a broader set that also included publications in Social Science and Humanities (SSH). A preliminary point to be made here is that the calculation of publications is vitiated by a great many inaccuracies for authors with two first names or two surnames in both the *Econlit* and *Google Scholar* databases, occasionally resulting in underestimation of the effective number of publications by the authors concerned. Moreover, there are many errors in the classification of publications by field of discipline, again resulting in underestimated figures. In some cases, for example, *Publish or Perish* came up with a lower number of publications than were obtained with direct consultation of *Google Scholar*.

The first major division within the universes is between those who have publications in the databases considered and those who have none in the period from 1969 to the present day. As can be seen in Tables 1 and 2, for *Google Scholar* we have two indexes, according as to whether the publications belong only to Business, Administration and Finance in *Publish or Perish* ($google_{\boldsymbol{BAFE}}$) or there are also publications in Social Science and Humanities ($google_{\boldsymbol{SSH}}$).

[11] For example, a book in Italian by one of the two authors of this paper is cited by a text in English, but the citation was detected only by *Google Libri*, while *Google Scholar* gave only the title of the Italian book and not the source of citation. In *Publish or Perish* the record (title of the Italian book) is simply missing.

Analysing the number of economists with at least one publication represented in the databases from 1969 to 2007, *Google Scholar*, with its broader definition (SSH), was found to show values systematically higher in all cases than the more limited aggregate of *Google Scholar* (BAFE). On average 83.9% of Italy's academic economists at least 1 *Econlit* publication, as against 79.1% with at least 1 record in $Google_{BAFE}$ and 85.7% with 1 record in $Google_{SSH}$. The only case in which the $Google_{BAFE}$ percentage of authors exceeded that of *Econlit* was for researchers, for here the age effect applied. The limited representation of publications prior to 1990 in *Google Scholar* led to underestimation of the number of economists (mainly in the older age group) that had published before 1990. Total correspondence was found between the aggregate data of $Google\ Scholar_{SSH}$ and *Econlit* for the full professors, while for the associate professors, except for the women, the $Google_{SSH}$ estimates came slightly lower than the Econlit figures, and the difference was more marked in the case of researchers (see Table 1).

Women were found to publish less: the men with at least one publication came to 86.7% as against 75.5% of the women (in comparison with $Google_{BAFE}$, respectively 82.6% and 68.9%).

Table 1 Economists with publications: Econlit, Google Scholar.

	Full professors			**Associate professors**			**Researchers**			**Total**		
	m	**f**	**tot**	**m**	**f**	**tot**	**m**	**f**	**tot**	**m**	**f**	**tot**
Econlit	572 **93,5%**	86 **93,5%**	658 **93,5%**	292 **86,9%**	113 **90,4%**	405 **87,9%**	175 **70%**	109 **57,1%**	284 **64,4%**	1039 **86,7%**	308 **75,5%**	1347 **83,9%**
Google$_{BAFE}$	536 **87,6%**	83 **90,2%**	619 **87,9%**	276 **82,1%**	97 **77,6%**	373 **80,9%**	177 **70,8%**	101 **52,9%**	278 **70,7%**	989 **82,6%**	281 **68,9%**	1270 **79,1%**
Google $_{SSH}$	572 **93,5%**	86 **93,5%**	658 **93,5%**	294 **87,5%**	112 **89,6%**	406 **88,1%**	196 **78,4%**	116 **60,7%**	312 **63%**	1062 **88,6%**	314 **77,0%**	1376 **85,7%**

Striking here is the high number of Italian economists without publications (see Table 2), ranging between 259 and 336, or, in terms of percentages, between 16.1% and 20.9% of the universe, according to the database used. On examination of the aggregates there would seem to be a uniformity in the data supplied by *Econlit* and $Google_{SSH}$, but actually the two databases capture *different names*. The authors with zero records number only 192 (74.1%) in both *Econlit* and $Google_{BAFE}$ alike; this figure falls to 172 if we take a broader area of studies into consideration (SSH). The greatest degree of correspondence is found for the associate professors, no fewer than 44 (78.6%) names being the same whether $Google_{BAFE}$ or *Econlit* is consulted, but for the remaining 12 *Econlit* authors with zero publications the $Google_{BAFE}$ records range between 1 and 3, apart from

the exception of one author with 34 publications. On the other hand the names correspond for 40 authors using $Google_{SSH}$. In the case of researchers a correspondence of 73.9% was found for the $Google_{BAFE}$ names (116) and 66.9% for $Google_{SSH}$ (105). Although Table 2 shows perfect correspondence between the *Econlit* and $Google_{SSH}$ data for full professors, the correspondence actually applies to only 27 names (59%).

Table 2 Economists with no publications: Econlit, Google Scholar.

	Full professors			**Associate professors**			**Researchers**			**Total**		
	m	**f**	**tot**	**m**	**f**	**tot**	**m**	**f**	**tot**	**m**	**f**	**tot**
Econlit	40 / **6,5%**	6 / **6,5%**	46 / **6,5%**	44 / **13,1%**	12 / **9,6%**	56 / **12,1%**	75 / **30%**	82 / **42,9%**	157 / **35,6%**	159 / **13,3%**	100 / **24,5%**	259 / **16,1%**
***Google**$_{BAFE}$*	76 / **12,5%**	9 / **9,8%**	85 / **12,1%**	60 / **17,9%**	28 / **22,4%**	88 / **19,1%**	73 / **29,2%**	90 / **47,1%**	163 / **37%**	209 / **17,4%**	127 / **31,1%**	336 / **20,9%**
***Google**$_{SSH}$*	40 / **6,5%**	6 / **6,5%**	46 / **6,5%**	42 / **12,5%**	13 / **10,4%**	55 / **11,9%**	54 / **21,6%**	75 / **39,3%**	129 / **29,3%**	136 / **11,4%**	94 / **23,0%**	230 / **14,3%**

There are some cases in which *Google Scholar* fails to capture publications that are, however, to be seen in *Econlit*; for example, 58 authors who appear to have had no publications on consulting $Google_{SSH}$, come up with between 1 and 4 records in *Econlit*. This group consists of 24 researchers, 15 associate professors and 19 ordinary professors; on analysing the publications appearing in *Econlit* but not in *Google Scholar*, almost all the articles were found to have been published in Italian journals; this applies to the associate professors for whom 50% (12 cases out of 24) of the articles were published after 1990, all in Italian journals. For the full professors, too, in all cases with three exceptions of books and one article, the publications that appear in *Econlit* but not in *Google* are accounted for by articles published in Italian journals, mostly subsequent to 1990. It is also interesting to consider the case of researchers who should have been favoured by use of *Google Scholar* instead of the *Econlit* database: actually, there were as many as 24 researchers who, while having a record registered in *Econlit* were not captured by the web. Here too the publications are accounted for by articles in Italian journals, and in 30 cases out of 39 other recent publication, between 1990 and 2007, including 18 published between 2000 and 2007.

And yet the contrary situation was also observed: in no fewer than 87 cases the authors showed at least one record in $Google_{SSH}$ but zero in *Econlit*; as one might have expected, researchers accounted for the overwhelming majority here (19 full professors, 16 associated professors and 52 researchers).

We may therefore conclude that the *Google*$_{SSH}$ and *Econlit* databases provide us with the same data in only 74.4% of the cases. The question arising at this point was, how is it possible for the web to come up with no records as from 1969 for the 172 authors with no publications in *Econlit* and *Google Scholar*? We then went on to search *Google Libri* , which provides data on practically all types of books[12]. What we discovered is that *Google Libri* offers additional data, not supplied by *Google Scholar*, in particular for books published by Italian publishing houses that do not appear searching *Google Scholar* by author. (see Table 3). Searching *Google Libri* while retaining the same 1969/2007 time constraint, of the 172 without publications appearing in both *Econlit* and *Google*, no fewer than 80 were found to have had at least one book published, mostly by Italian publishers, in general minor or University editions, but in some cases publishers of national standing (Il Mulino, Giappichelli, Carocci). In particular, of the 27 full professors showing no *Econlit* or *Google Scholar* record, only 6 non had no record in *Google Libri*, while the number of women full professors remained unchanged (3). Moreover, 77.8% of the full professors with no *Econlit*/*Google Scholar* publications had at least one book in *Google Libri*; the same applied to 67.5% of the associate professors, while the effect was less pronounced for researchers, only 30% having at least 1 record in *Google Libri.*

The important conclusion that this exercise leads us to is that measurement of scientific production is greatly influenced by the choice of database; those most widely used at the international level (*Econlit* and *Google Scholar*) seriously underestimate Italian production, while search engines apparently interrelated, like *Google Scholar* and *Google Libri*, are actually nothing of the sort.

Table 3 Economists without publications: Econlit, Google Scholar and Google Libri.

	Full professors			**Associate professors**			**Researchers**			**Total**		
	m	**f**	**tot**	**m**	**f**	**tot**	**m**	**f**	**tot**	**m**	**f**	**tot**
***Econlit* =0 *Google* $_{SSH}$=0**	24	3	27	30	10	40	39	66	105	93	79	172
***Google*$_{libri}$ =0**	3	3	6	11	2	13	24	49	73	38	54	92

[12] Books of narrative, non-fiction, consultation, academic, scholastic, for children, scientific, medical, professional, didactic, etc., thanks to the continual inclusion of new books from partner libraries and publishers collaborating on the project. The books now present amount to about 7 million – not only digitalised but also books covered by copyright.

We then calculated the index of visibility (see Marcuzzo-Zacchia 2007) offered by the ratio between the number of authors with at least one publication and the total number of economists considered. In general 84% of Italy's academic economists had at least one publication entered in *Econlit*, as against the 85.7% calculated with *Google Scholar* with the broader definition of search sector. With all the databases used the visibility index proved to be closely correlated with academic ranking, the percentage of full professors with at least one publication recorded exceeding that of the associate professors and researchers (Table 4). Here again we find a slight distortion occurring due to the age factor: the gap between full professors and researchers narrows in percentage terms if we make reference to *Google Scholar* rather than *Econlit*.

Using $Google_{SSH}$ we find a slightly higher visibility index than with *Econlit* in the case of associate professors (87.9% as against 88.1%) and researchers (83.9% as against 85.7%), while the statistics show no variation for the ordinary professors with the two databases. Again, this is to be accounted for with the same point we made about the absence of certain authors from one database, but not from the other; as we have seen, the authors with at least one record in *Econlit* and zero in $Goggle_{SSH}$ numbered 58 as against 83 authors with records in $Google_{SSH}$ showing no publications in *Econlit.*

The only case showing underestimation of the index percentage value is for women associate professors: in this case alone the visibility index comes to 90.4% with *Econlit* but 89.6% with $Google_{SSH}$. This can be explained with the fact that the number of women associate professors present in *Econlit* and not in $Google_{SSH}$ (3) exceeds that of the same category present in $Google_{SSH}$ and not in *Econlit* (2). Combining $Google_{SSH}$ with *Google Libri*, and of course retaining the same time constraint (1969/2007), we observe a sharp rise in the visibility index, from the 85.7 % for academics with at least one publication between 1969 and 2007 to 92.8%. In general the index is found to improve for women (77% as against 84.6%); not only for researchers, but also for ordinary professors and associate professors increases are noted in the index values, of 5% and 9% (see Table 4.1).

Tab. 4 Visibility indicators: Econlit, Google Scholar

	Full professors			**Associate professors**			**Researchers**			**Total**		
	m	**f**	**tot**	**m**	**f**	**tot**	**m**	**f**	**tot**	**m**	**f**	**tot**
Econlit	93,5%	93,5%	93,5%	86,9%	90,4%	87,9%	70,0%	57,1%	64,4%	86,7%	75,5%	83,9%
Google $_{BAFE}$	87,6%	90,2%	87,9%	82,1%	77,6%	80,9%	70,8%	52,9%	63,0%	82,6%	68,9%	79,1%
Google $_{SSH}$	93,5%	93,5%	93,5%	87,5%	89,6%	88,1%	78,4%	60,7%	70,7%	88,6%	77,0%	85,7%

Tab. 4.1 Visibility indicator in combination with Google Libri

	Full professors			Associate professors			Researchers			Total		
Google$_{SSH}$ e Google Libri	**m**	**f**	**tot**	**m**	**f**	**tot**	**m**	**f**	**tot**	**m**	**f**	**tot**
	605 / 98,9%	87 / 94,6%	692 / 98,3%	322 / 95,8%	122 / 97,6%	444 / 96,3%	218 / 87,2%	136 / 71,2%	354 / 80,3%	1145 / 95,6%	345 / 84,6%	1490 / 92,8%

The limitation of the visibility indicators is that they tell us only if an author has at least one record in the databases considered; to construct an index of overall quality of scientific production we also need to know where and in what quantity the publications come out. Following the practice of Marcuzzo- Zacchia 2007, we used as productivity indicator the median, and not the simple mean of publications since a markedly asymmetric distribution was observed in the number of publications according to the analysis universes taken into consideration. The median number of publications for Italy's academic economists came to 7 with *Econlit* and 8 with *Google$_{SSH}$*.

The productivity index, too, was found to be greatly influenced by academic ranking and sex (Table 5). As in the case of the visibility index, the productivity index values proved higher using *Google Scholar* as database rather than *Econlit.*

Table 5 Productivity indicators: Econlit, Google Scholar

	Full professors			Associate professors			Researchers			Total		
	m	f	tot	m	f	tot	m	f	tot	m	f	tt
Econlit	12	9	12	6	6	6	3	2	2	7	5	7
Google$_{BAFE}$	12	11	12	7	8	7	5	3	4	8	5	8
Google $_{SSH}$	13	12	13	8	8	8	5	4	5	9	6	8

3. "Citations or weighted numerousness: *h* index and *EconlitNumber*"

The information content offered by the simple number of publications not weighted according to their quality is too low, or even distorted, to be used in evaluation exercises; hence the need to create indexes adjusting the number of publications on the basis of their "importance". In this section we will describe two indicators that capture data on the number of publications and their "quality"; in both cases we have the weighted numerousness of publications by a single author: in one case, the number of records is weighted according to the relevant citations received (*h* index), while in the other the weight attributed to each publication is based on typology and the quality of

the journal/ publishing house where the publications appeared (*EconlitNumber*). Let us begin with a brief description of the two indexes so that the positive and negative aspects of each may be apparent.

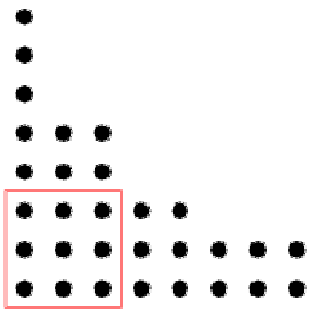
The h index

The *h* index, created by Jorge E. Hirsh (2005), is defined thus: a researcher has an *h* index if amongst all her/her papers published, amounting to *N*, there are h that have at least h citations each, while the remaining papers, *N-h*, have at the most h citations each.[13] This index is rapidly gaining ground in the scientific world, to the extent that the ISI *Web of Science* recently included it among the significant parameters in the *Citation Report* which the *Web of Science* provides by author, and also in *Scopus*, which calculates the *h* index of each author. With the *Publish or Perish* program, which we made use of in the previous section the this paper, it is possible to calculate the *h* index of authors and number of citations of single publications in just a few seconds. Today the *h* index is the bibliometric index most simply and rapidly calculated with a free software program.

Graphic illustration with an example represents this in a way that is readily grasped: first we order the publications on the basis of number of citations received in decreasing order, and then give the number of publications on the x-axis and the number of citations on the y-axis.

In the example in *Fig.* 1 we have an author who has 8 publications: of these, three have received 2 citations, two 3 citations, two more 5 citations and one 8 citations. The dimension of the resulting square (citations=publications) is evident, and the *h* index of the author considered is seen to be 3.

Fig. 1 Graphic representation of the h index



[13] The *h* index corresponds to the dimension of the Durfee square in the Ferrers graph.

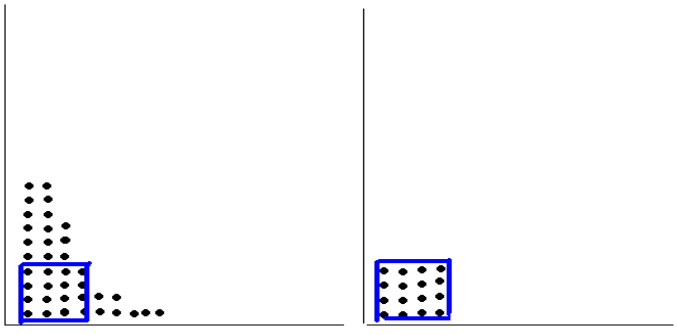
Thus the *h* index has the advantage of capturing two significant data – the number of the author's publications and the number of citations – in a single number. We can therefore take the *h* index to represent weighted numerousness, in that it attribute zero weight to all the publications that do not come within calculation of the index itself – the publications, that is, that have received a number of citations short of *h* or distinctly in excess of it, but falling outside the dimension of the Durfee square – while the publications coming within the index calculation, whatever the number of citations received, are attributed with a weight corresponding to one. In this way the *h* index favours those authors who continue to publish papers of a certain impact and penalises those who occasionally publish much cited papers and authors who produce many papers that receive little attention. It is to be borne in mind that this index is greatly affected by the database used since it takes in all types of publications provided they are "caught" in the search engine net.

Naturally, the *h* index is not entirely immune to problems: below we list some of the major limitations and the solutions proposed in the literature.

1. *It "misses" data*

The *h* index is subject to a loss of data since it "cuts off the tails" of publication distribution on the basis of number of citations, penalising authors whose relatively few publications are much cited. Let us take yet another example with graphic illustration: the two authors represented in *Fig.* 2 have the same *h* index, amounting to 4, although their production differs greatly: one has only four publications with 4 citations each, the other 9 publications of which no fewer than 3 have received a number of citations above *h* index(>3 in our example, 2 with 10 citations and 1 with 7 citations).

Fig. 2: Data loss with the h index



A number of solutions to this problem have been advanced in the literature. To reduce the effect in the case of authors with few publications but much cited, Egghe (2006) suggests the ***g*** index**,** indicating the highest number of papers, *g,* which have received all together at least g^2 citations. The Jin index (Jin *et al*. 2007), also known as ***A*** index, on the other hand, uses the mean number of citations received by the h publications that determine the *h* index(*h* core). In this case the papers having most impact are attributed with a weight proportional to the number of citations received, according to the following formula:

$$A = \frac{1}{h}\sum_{j=1}^{h} citation_j$$

2. *it penalises the younger*

The *h* index tends to be higher for the older age classes even when they no longer publish or are no longer cited. In this case Hirsch himself suggested adjusting the value of h, dividing it by the academic age (***m*** index), demonstrating the possibility of intergenerational comparison between authors with this method: a value *m* of 1 denotes an author of average quality, while values amounting to 2 and 3 indicate authors well above average. Sidiropoulos *et al.* (2006) also propose attributing greater weight to the more recent papers so as to favour the authors who are still productive rather than authors who no longer publish their work, thereby reducing the impact of the time factor.

3. it depends on the database used

The *h* index varies considerably according to the source of data employed, whether *Google Scholar*, *Scopus* or *Web of Science*. *Web of Science* has extensive coverage of articles, but rather more limited coverage of working papers, while both *Scopus* and *Google Scholar* have limited coverage in terms of time spans, most of the publications being from the 1990s on. According to Meho (2007)[14] in the field of information technology sciences *Google Scholar* exceeds the number of *Web of Science* citations by 160%, and *Scopus* citations by 35%. To evaluate the extent to which this tendency also applies to other disciplines it would be necessary to compare databases, but in any case it is worth bearing in mind that the results vary greatly according to which set of citations is employed.

4. it does not eliminate self-citation

In calculating the *h* index citations of national paper are take into consideration regardless of whether they are self-citations or negative citations, the criterion being "so long as they are talked about". However, Meho (2007) has calculated the *h* index for information technology sciences with and without self-citation, finding that in most cases the index value shows no difference.

5. *it does not take co-authors into account*

Since self-citations are included in calculation of the *h* index, co-authors have a greater advantage than authors who publish alone. For example, Persson *et al*. (2008) found a significant correlation between the number of researcher's co-authors and the mean number of citations per year. One solution has been advanced by Batista *et al.* (2005),who divide the *h* index by the mean number of authors of the h publications that determine it.

6. *it does not lend itself to comparison between different areas of disciplines*

Given the very considerable difference between the average numbers of publications in the individual areas of disciplines, interdisciplinary comparison of *h* indexes is not significant, unless the values are normalised to reflect the average numerousness of citations in the various disciplines (see van Raan 2005 and Podlubny 2005).

Thus the *h* index has the advantage of summing two such significant data as the number of publications and a number of citations received, allowing for international comparison of the scientific production of authors of various nationalities. Nevertheless, the identification between quality and the number of citations gives rise to various problems – as listed above – and in particular the *h* index can grow over the years not only because publications have been produced but also because the citations have multiplied. For example, an author may no longer be publishing but still seeing his/her *h* index increasing over the years because his/her "old" papers are cited. Moreover, citations gradually accumulate in the course of time, and a certain period of time must therefore go by as from the date of publication to be able to count them.

EconlitNumber

EconlitNumber is a weighted productivity index designed to adjust in terms of "quality" the simple number of publications obtained searching the *Econlit* database by author. In this case "quality" is not identified with the number of citations received, as in the case of the *h* index, and it has a twofold connotation. On the one hand it takes into account the effort required for each type of product, attributing different weights according to the publication typology: consequently books

will have a greater weight than articles, and articles in turn more weight than working papers. On the other hand, the *quality* of the edition in which the publication appears is also taken into account, measured on the basis of the rankings of journals and publishing houses produced in the literature not with the use of bibliometric indexes alone, but combined with peer review.

In this way the *EconlitNumber* of each author would be calculated thus:

$$EconlitNumber = \left[\sum_{i,j}\left(\beta \cdot \delta_j \cdot A_{ji}\right)\right] + \left[\sum_{i,g}\left(\beta \cdot \gamma_g \cdot B_{ig}\right)\right] + \left[\sum_{i}\left(\beta \cdot WP_i\right)\right]$$

For each product i, whether an article (A), book (B) or working paper (WP), β is the weight attributed to each typology, δ is the quality coefficient attributed to each journal j, and γ is the quality coefficient attributed to each publishing house g.

EconlitNumber provides in simple and summary form the data found for evaluation of the quality/quantity of research in economics. The problem is to identify the numerical value to be attributed to each of the single weights: here we offer some examples:

β = can sum three values according to the publication typology: 1.5 for a monographic study, 1/2 in the case of a paper in a journal or volume of collected papers, 1/5 for working papers[15].

γ = quality of the publishing house; for classification choice fell on the University of Utrecht Classification Scheme – CERES Ranking of Publishers in Economics[16]; □ can take on 6 values according to the classification of the University of Utrecht, ranging from 1 in the case of a publisher entered in class A to 1/6 for publishers not appearing in the list of publishing houses.

[15] For the working papers it is not possible to weigh on the basis of the quality of the context in which published. However, we attribute a low weight to working papers in line with the choices of various Italian universities, as in the research evaluation exercise carried out by the faculty of economics of the University of Florence and of Ca' Foscari. In the case of the *EconlitNumber* the weight of working papers amounts to the minimum value that the index can show in the case of a paper published in a journal absent from the CNRS 2008 ranking http://www.gate.cnrs.fr/spip.php?article198&lang=fr

[16] http://www.keele.ac.uk/depts/ec/cer/documents/CERESlist.pdf Classification of the publishing houses covers 5 categories (from A to E) according as to whether the publishing house has a transparent referee mechanism; publishers having no such mechanism are given weight D in the case of publishers for academic readership, E for non-academic readership.

δ = following the model adopted by the French National Committee for Scientific Research (CNRS 2008) in classifying economics and management journals [17] we adopt not a *ranking* but a *range* of journals[18]; δ can therefore take on 6 values according to the CNRS classification, ranging from 1.5 (CNRS 1*) to 1/5 for all publications in journals not included in the CNRS list. Here we decided to adopt a scale above the publishing house scale since we believe that an article published in a journal considered among the most prestigious must have greater weight than an article appearing in a volume of collected articles brought out by one of the best publishers.

The *EconlitNumber* has the advantage of summing with a single number various data that can provide a multilateral definition of the "quality" of the publication, not limited to the number of citations received but also taking into account the effort and the quality of the context in which the work was published.

Non-identification of quality with the number of citations received also avoids the problem of the temporal mismatch penalising the younger authors, who obviously have fewer citations: in calculating the *EconlitNumber* all the publications are considered and weighed according to the typology and quality of the edition in which they are published. This, in fact, is a further advantage, since there is no data loss as in the case of the *h* index. Moreover, the *EconlitNumber* also registers continuity of production over time, which makes it more appropriate for exercises to define the minimum thresholds of scientific production.

Obviously, the *EconlitNumber* it is not immune to criticism either: here we list the major limitations to be noted:

1. <u>*it summarises too many data*</u>

The virtue of being a multi-dimensional measure of scientific production is also its major defect: summarising a quantity of data, the risk with the *EconlitNumber* is that the datum of measurement

[17] Comité National de la Recherche Scientifique, Catégorisation des revues en Économie et en Gestion, has a classifications in 5 categories (from 1*, excellent, to 4) of economic and marketing journals in English and French (696 in total), on the basis of impact (and thus of bibliometric indexes), the judgement of experts in the disciplinary sector, and scientific reputation, on the basis of data provided by, for example, *Econlit* and the *Social Citation Index*. http://www.gate.cnrs.fr/spip.php?article198&lang=fr

[18] In the CNRS report (*CNRS - Classement des revues 2008*) it is stressed that the work is not a ranking but subdivision of the journals into categories: "Dans l'interprétation de la liste, il importe de garder à l'esprit qu'au sein de chacune des quatre catégories ordonnées que nous avons distinguées il subsiste une certaine variabilité en terme de qualité. C'est pourquoi nous employons le mot «catégorisation » plutôt que classement".

of "quality" in the strictest sense (here defined in terms of where the publication appears) may be lost sight of.

2. *highly dependent on weights*

The index is greatly affected by the rankings of the journals and publishing houses used; there is also the problem of weighing the journals/books with "temporally" compatible rankings: it would be perfectly useless to weigh publications of the 1970s on the basis of rankings of recent journals/publishing houses since the quality of journals/publishing houses can also change in the course of time. It is therefore necessary to apply rankings adjusted to the date of publication of the records.

3. it penalises writers of books mostly not in the English language

Since *Econlit* this is the standard database for calculation of the *EconlitNumber*, the authors of books in Italian brought out by Italian publishing houses are penalised. However, the *EconlitNumber* can easily be integrated with other databases like ESSPER[19], the database provided in portal OPAC, comprising mostly books in Italian and small monographic studies, and of course *Google Libri*, which captures the production of Italian economists not surveyed by *Econlit* nor indeed by *Google Scholar*[20]. By doing so we can construct an *EconNumber* for each economist for the chosen time span that takes into account all the publications not appearing in *Econlit*.

3. *it fails to take into account the number of co-authors:*

Calculation of the Nel *EconlitNumber* fails to take into account the presence of co-authors, but this datum can easily be added adjusting the *EconlitNumber* with a weight amounting to 1/n, n being the number of co-authors.

4. *It does not serve for comparison between different disciplinary areas*

EconlitNumber is an index of academic production applied solely in economics, therefore allowing for comparison only within the area of the economic sciences. However, the index is of use for international comparison since the relevant database includes publications of various nationalities.

[19] Launched in 1996, it contains articles from Italian journals.

[20] An example of *EconNumber* construction can be seen in Marcuzzo- Zacchia (2007).

4. "Evaluating" Italy's academic economists: *h* index and *EconlitNumber* compared

In this section we will use the *EconlitNumber* and *h* index (applied to the broader SSH area) to "evaluate" Italian academic economists holding permanent positions as of 31/01/2007.

We calculated the two indexes taking reference from publications appearing between 2004 and 2006 for two reasons: firstly, to produce results that would be comparable with the first report on evaluation of scientific research for the three-year period 2001-2003 drawn up by the Committee for Evaluation of Research (CIVR), and secondly in order to be able to use rankings of journals and publishing houses neither too "far" from those of the publications taken into consideration nor, however, too "near". In fact, for the purpose of our exercise in weighting publications produced between 2004 and 2006 in the *EconlitNumber* we made use of the ranking of journals by the CNRS drawn up in 2008 and, for the publishing houses, the 2007 *University of Utrecht* ranking produced to evaluate university research activities.

For the *h* index, too, there were good reasons for choosing the three-year period 2004-2006 since this index is greatly influenced by the year of publication given that the chances of being cited increase over time; in fact, we chose to consider a period of between 5 and 3 years from the date of publication (the *h* index was calculated in 2009), so as not to favour full professors while penalising the younger economists.[21]

As we have seen, *Google Scholar* captured a greater number of publications in the 2004/2006 time span than *Econlit*: on average, *Google Scholar* captured 4.95 publications per author while *Econlit* detected less than half that number – only 1.99 publications per economist. Moreover, *Google Scholar* succeeds better in capturing the publications of the younger economists; using *Econlit* researchers are found to have 60.96% fewer publications than full professors, while the gap narrows to 42.55% using *Google Scholar* as database.

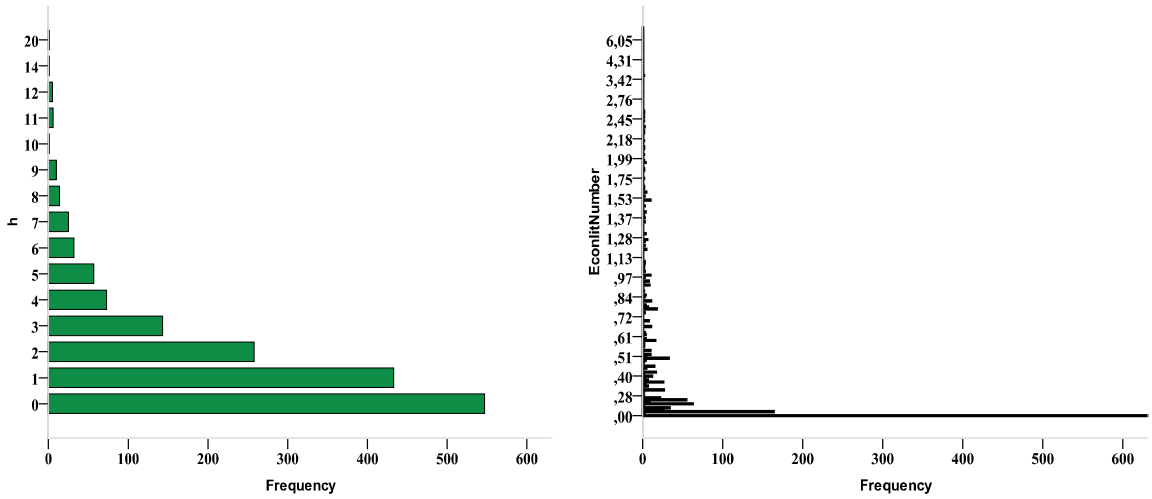
On average, the *h* index for academic economists for the period 2004/2006 comes to 1.68, which means that between 2004 and 2006 each author on average had more than one publication cited at least once. The average *EconlitNumber* comes to 0.43; this value is compatible with a combination of different publications: with 3 papers in the low range of the CNRS ranking and 1 working paper, for example, or 3 papers, two of which in a journal in the middle range and 1 in a journal of the low

[21] According to the calculations by Checchi and Jappelli (2008), the "*h* index tends to be one point higher every eight years of scientific activity".

range, or, again, 1 book brought out by a middle-range publisher and 2 papers, 1 in a middle-range journal and 1 in a low range.

For both indexes the distribution is markedly asymmetric; suffice it to consider the fact that 34.1% of the academics have a zero *h* index and 42.4% a zero *EconlitNumber*; only 0.9% have an *h* greater than 10 and 1% an *EconlitNumber* above 5.

Fig. 3: EconlitNumber and h index frequency distribution 2004-2006



We then took into consideration the 50 economists with the highest *h* index and *EconlitNumber*, to find that only half the names corresponded for each; in fact, just 26 names were common to the two indexes. For the remainder there was no correspondence; indeed, one economist with *h* at 8 had a zero *EconlitNumber*, while an economist with *EconlitNumber* at 3.32 had an *h* of 1 (see Figs. 4 and 5).

Fig. 4: 50 economists with highest h index 2004 2006

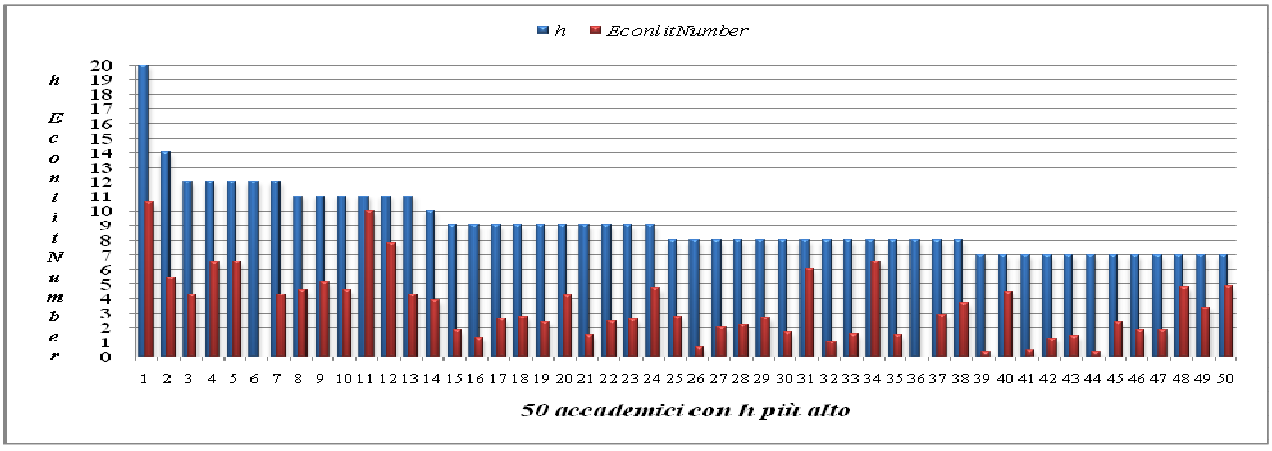
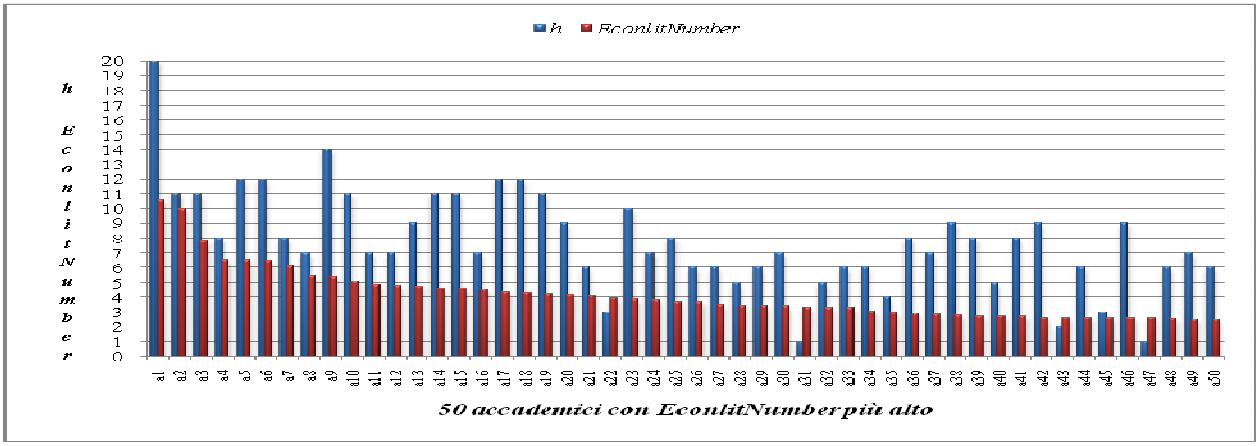


Fig. 5: 50 economists with highest EconlitNumber 2004-2006



If we go on from the individual to aggregate level and consider the classification of the universities on the basis of the respective indexes, we again find quite considerable differences (see Appendix 1). At the top of the classification we find limited overlapping: the S. Anna of Pisa and Bocconi of Milan are in the top two positions by mean value, but also to be noted is the great difference in numerousness which has to be taken into account in one way or another. In the top positions we find striking differences: Brescia takes 7th place according to the *h* index, but 17th according to the *EconlitNumber*, while Urbino comes 11th and 30th respectively. At the middle level Cassino takes 25th place according to the *h* index but 48th according to the *EconlitNumber*, while the University of Calabria takes the 44th and 54th place in the two cases.

What matters for us here is not so much the fact that using the two methods of weighting numerousness (number of citations in one case, ranking of the contexts in which the publications appear and their typology) different results are obtained, but rather the attempt to interpret what data they can give us, and so what end they can be utilised.

Since the *h* index underestimates numerousness and measures quality solely on the basis of the number of citations – not all the publications are considered, but only those that have received at least *h* citations – we do not see it as an instrument particularly suited to use, for example, for the allocation of university research funds, a number of products being excluded because either not cited or cited too little. Thus the ranking positions of the universities could depend on factors that reflect neither the quality nor the numerousness of production.

EconlitNumber shows a certain arbitrariness in the choice of weights, but proves better suited for use in allocation of resources and definition of "minimum requisites" for individuals or Departments, even simply in terms of differences from a mean value for facilities of equal dimensions.

To evaluate the usefulness of these two indexes in constructing facility classifications, we attempted comparison with the CIVR ranking for area 13. Despite the different methodology used and the different time span for the publications considered, if we reallocate the individual universities in the CIVR categories (mega, a large, medium and small dimensions) we can attempt to compare the rankings. To offer but one example, considering the top of the CIVR classification of middle-sized universities (between 10 and 24 products), Modena and Reggio Emilia, among the 31 universities of its class, drops to 23rd place for *h*, and 12th for *EconlitNumber* (see Table 6).

Another interesting aspect is the ranking for faculties rather than universities. Here again the non-correspondence of the two index orders is confirmed. Statistical Sciences at the Rome University "Sapienza" holds 11th position for *EconLitNumber* and 44th for the *h* index; Economics at Modena and Reggio Emilia comes 26th for the *h* index but 57th for *EconLitNumber*; Economics at Urbino holds the 6th position for *h* and the 32nd for *EconlitNumber* .

If we compare our results with those of Checchi-Jappelli (2008), regarding the publications of full professors alone (696) on the permanent staff in 2008 with no time constraint, the faculty order again shows considerable differences apart from the first two places (Social Sciences at Sant'Anna and Economics at Bocconi). This is further confirmation of the extent to which these classifications depend on the year of consultation and the relevant population, calling for considerable caution in interpretation.

Table 6 University ranking comparison for CIVR 2006, h and EconlitNumber 2004-2006

CIVR ranking	h ranking	EconlitNumber ranking	University	Permanent staff
1	23	12	MODENA e REGGIO EMILIA	29
2	12	9	SALERNO	34
3	16	23	PAVIA	31
4	20	17	PADOVA	45
5	15	5	CHIETI-PESCARA	20
6	27	15	URBINO "Carlo BO"	15
7	30	29	PIEMONTE ORIENTALE	18
8	21	28	MILANO-BICOCCA	31
9	22	14	BERGAMO	22
10	26	26	TRENTO	28
11	24	27	MILANO	38
12	25	18	"Cà Foscari" di VENEZIA	33
13	9	21	ROMA TRE	40
14	1	1	TRIESTE	20
15	11	24	PISA	39
16	6	13	UDINE	10
17	7	3	della CALABRIA	20
18	28	25	BRESCIA	25
19	14	19	CAGLIARI	32
20	5	2	PARMA	24
21	2	10	PALERMO	24
22	3	6	CATANIA	31
24	18	20	Politecnica delle MARCHE	28
25	13	16	VERONA	25
26	8	8	PERUGIA	20
27	17	7	CASSINO	13
28	29	30	ROMA "Tor Vergata"	52
29	10	11	MESSINA	19
30	4	4	GENOVA	30
31	19	22	"Parthenope" di NAPOLI	21

5. Some brief conclusions

Numerousness of citations as proxy for the quality of a publication is an extremely limiting criterion, and the *h* index, as we have sought to show in its application to Italy's academic economists, is not always a reliable bibliometric index. The simplicity of calculation – due to the availability of free, user-friendly software – should not be an incentive to use it in evaluation exercises. A simple algorithm recalculating the publications in the MIUR-Cineca file of academics, attributing the necessary weights, would prove an equally rapid and simple way of obtaining a broad indicator of the production we wish to evaluate. This weighted numerousness index – supposing the scientific community is able to come to agreement in general terms on the weight to attribute to typology and context of publication – would certainly be preferable. In this paper we have suggested that the *EconlitNumber* or *EconNumber* could have more suitable requisites as bibliometric indicators to use in rankings of Universities, Faculties or Departments.

In future developments in Italy the use of bibliometric indicators for purposes of resource allocation – human and otherwise – to the university on the basis of research quality is inevitable, and precisely for this reason it is important that they should be refined so as to prove more useful and efficacious, and less distorted.

However, we may usefully conclude with an observation by two authors of a recent study: "All measurements of research quality should be taken with a grain of salt; it is certainly not possible to describe a scientist's contributions to a given research field with mere numerical values. As Albert Einstein famously noted: '[n]ot everything that counts is countable, and not everything that's countable counts." (Bornmann *et al.*, 2009. p. 6).

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Appendix1. University ranking by h and EconlitNumber 2004-2006[22]

h ranking	University	Permanent staff	h mean value	h median value	EconlitNumber ranking	University	EconlitNumber mean value	EconlitNumber median value	Permanent staff
1	S.ANNA di PISA	6	5,83	6,50	1	S.ANNA di PISA	1,7850	1,6350	6
2	MILANO Bocconi	45	3,67	3,00	2	MILANO Bocconi	1,4140	,5000	45
3	PIEMONTE ORIENTALE	18	2,78	2,00	3	LUISS "Guido Carli" - ROMA	,8575	,4250	16
4	ROMA "Tor Vergata"	52	2,56	1,50	4	ROMA "Tor Vergata"	,8123	,3600	52
5	INSUBRIA	15	2,47	2,00	5	SIENA	,7488	,3250	42
6	SIENA	42	2,43	2,00	6	INSUBRIA	,7340	,2700	15
7	BRESCIA	25	2,40	2,00	7	Politecnico di MILANO	,7018	,2500	11
8	LUISS "Guido Carli" - ROMA	16	2,31	2,00	8	PIEMONTE ORIENTALE	,6967	,4250	18
9	Libera Università di BOLZANO	4	2,25	2,00	9	TORINO	,6507	,1500	82
10	FERRARA	17	2,18	1,00	10	BOLOGNA	,6411	,2500	95
10	TERAMO	11	2,18	2,00	11	Libera Università di BOLZANO	,6175	,4850	4
11	URBINO "Carlo BO"	15	2,13	1,00	12	FERRARA	,5871	,2000	17
12	Politecnico di MILANO	11	2,09	2,00	13	MILANO-BICOCCA	,5277	,2000	31
13	BOLOGNA	95	2,07	1,00	14	MILANO	,5216	,1000	38
14	TORINO	82	2,05	1,00	15	TRENTO	,4986	,1700	28
15	TRENTO	28	2,04	2,00	16	TERAMO	,4936	,3400	11
16	"Cà Foscari" di VENEZIA	33	2,03	1,00	17	BRESCIA	,4920	,4400	25
17	MILANO	38	1,87	1,00	18	PISA	,4846	,0000	39
18	MODENA e REGGIO EMILIA	29	1,86	2,00	19	FIRENZE	,4376	,2000	41
19	BERGAMO	22	1,82	2,00	20	PAVIA	,4345	,2500	31
20	MILANO-BICOCCA	31	1,81	2,00	21	"Parthenope" di NAPOLI	,4224	,2000	21
21	CAMERINO	4	1,75	,50	22	ROMA TRE	,3965	,0500	40
22	BARI	35	1,74	1,00	23	Univ. del SALENTO	,3954	,4200	13
23	"Parthenope" di NAPOLI	21	1,71	1,00	24	Cattolica del Sacro Cuore	,3889	,1000	53
23	FOGGIA	17	1,71	1,00	25	Politecnica delle Marche	,3868	,1350	28
23	PADOVA	45	1,71	1,00	26	CAGLIARI	,3731	,1350	32
23	SANNIO di BENEVENTO	7	1,71	1,00	27	"Cà Foscari" di VENEZIA	,3682	,0000	33
24	Cattolica del Sacro Cuore	53	1,70	1,00	28	PADOVA	,3569	,2000	45
24	Politcnica delle Marche	28	1,7	1,00	29	VERONA	,3392	,1000	25
25	CASSINO	13	1,69	1,00	30	URBINO "Carlo BO"	,3380	,2000	15
26	Seconda Univ. NAPOLI	9	1,67	1,00	31	L'AQUILA	,3363	,0000	8
27	FIRENZE	41	1,66	1,00	32	SANNIO di BENEVENTO	,3286	,1000	7

[22] To avoid measurement errors we excluded universities with fewer than four academics.

28	PAVIA	31	1,58	1,00	33	NAPOLI "Federico II"	,3253	,0000	51
29	SASSARI	12	1,58	1,00	34	BERGAMO	,3245	,1000	22
30	CHIETI-PESCARA	20	1,55	1,00	35	UDINE	,2850	,2000	10
31	CAGLIARI	32	1,50	1,00	36	SASSARI	,2792	,0500	12
31	MOLISE	8	1,50	1,00	37	MACERATA	,2758	,1000	19
32	VERONA	25	1,44	1,00	38	Seconda Univ. NAPOLI	,2733	,1300	9
33	Univ. del SALENTO	13	1,31	1,00	39	ROMA "La Sapienza"	,2725	,1000	120
34	SALERNO	34	1,26	1,00	40	MODENA e REGGIO EMILIA	,2714	,1300	29
35	PISA	39	1,23	1,00	41	MESSINA	,2663	,0000	19
36	MESSINA	19	1,21	,00	42	PALERMO	,2508	,0000	24
37	ROMA TRE	40	1,20	,50	43	MOLISE	,2488	,1000	8
37	Università IUAV di VENEZIA	5	1,20	2,00	44	SALERNO	,2406	,1000	34
38	L'AQUILA	8	1,13	1,00	45	Università IUAV di VENEZIA	,2300	,1000	5
39	MACERATA	19	1,11	1,00	46	PERUGIA	,2035	,0000	20
40	NAPOLI "Federico II"	51	1,08	1,00	47	CAMERINO	,1950	,1150	4
41	ROMA "La Sapienza"	120	1,07	1,00	48	CASSINO	,1769	,1000	13
42	PERUGIA	20	1,05	,00	49	BARI	,1734	,0000	35
43	"L'Orientale" di NAPOLI	5	1,00	1,00	50	CATANIA	,1535	,0000	31
43	Libera Univ. "Maria SS.Assunta"-LUMSA - ROMA	4	1,00	,50	51	CHIETI-PESCARA	,1385	,1000	20
44	della CALABRIA	20	,95	1,00	52	GENOVA	,1327	,0000	30
45	UDINE	10	,90	1,00	53	TUSCIA	,1188	,1000	8
46	PARMA	24	,88	,50	54	della CALABRIA	,1140	,0000	20
47	GENOVA	30	,83	1,00	55	PARMA	,0883	,0000	24
48	IULM - MILANO	5	,80	,00	56	Libera Univ. "Maria SS.Assunta"-LUMSA – ROMA	,0875	,0850	4
49	CATANIA	31	,77	,00	57	"L'Orientale" di NAPOLI	,0800	,0000	5
50	PALERMO	24	,75	,00	58	TRIESTE	,0765	,0500	20
51	TRIESTE	20	,50	,00	59	FOGGIA	,0659	,0000	17
52	TUSCIA	8	,38	,00	60	"S. Pio V"	,00	,00	5
53	Mediterranea di REGGIO CALABRIA	4	,25	,00	60	IULM - MILANO	,00	,00	5
54	"S. Pio V"	5	,00	,00	60	Mediterranea di REGGIO CALABRIA	,00	,00	4

Appendix 2. Faculty University ranking by h and EconlitNumber 2004-2006

Permanent staff	*University*	*Faculty*	*per h ranking*	*h meanvalue*	*h medianvalue*	*University*	*Faculty*	*EconlitNumber ranking*	*EconlitNumber mean value*	*EconlitNumber median value*
6	S.ANNA di Pisa	SC SOCIALI	1	5,8333	6,50	S.ANNA di Pisa	SC SOCIALI	1	1,7850	1,6350
45	MILANO Bocconi	ECONOMIA	2	3,6667	3,00	MILANO Bocconi	ECONOMIA	2	1,4140	,5000
7	PIEMONTE ORIENTALE	ECONOMIA	3	3,4286	2,00	PAVIA	GIURISPRUDENZA	3	1,2125	,4500
9	PADOVA	ECONOMIA	4	3,3333	3,00	LUISS "Guido Carli" - ROMA	ECONOMIA	4	,9477	,5000
12	INSUBRIA	ECONOMIA	5	2,8333	2,00	ROMA "Tor Vergata"	ECONOMIA	5	,9087	,4200
11	URBINO "	ECONOMIA	6	2,7273	2,00	TORINO	ECONOMIA	6	,9067	,3000
46	ROMA "Tor Vergata"	ECONOMIA	7	2,6957	2,00	INSUBRIA	ECONOMIA	7	,8950	,3500
13	LUISS "Guido Carli" - ROMA	ECONOMIA	8	2,6923	2,00	PIEMONTE ORIENTALE	ECONOMIA	8	,8814	,4700
7	PADOVA	SC STATATISTICHE	9	2,5714	2,00	BOLOGNA	SC STATATISTICHE	9	,8700	,3050
8	PIEMONTE ORIENTALE	SC POLITICHE	10	2,5000	2,00	PADOVA	ECONOMIA	10	,8511	,7500
12	BOLOGNA	SC STATATISTICHE	10	2,5000	2,00	ROMA "La Sapienza"	SC STATATISTICHE	11	,8192	,7200
37	SIENA	ECONOMIA	11	2,4865	2,00	TORINO	LETTERE	12	,8160	,6300
26	MILANO	SC POLITICHE	12	2,4615	2,00	MILANO-BICOCCA	ECONOMIA	13	,7550	,2500
15	FERRARA	ECONOMIA	13	2,4000	2,00	SIENA	ECONOMIA	14	,7538	,3400
10	PISA	INGEGNERIA	14	2,3000	2,50	PISA	INGEGNERIA	15	,7330	,4000
26	BOLOGNA	SC POLITICHE	15	2,2692	2,00	politecnico di milano	INGEGNERIA	16	,7213	,2750
4	Libera Università di BOLZANO	ECONOMIA	16	2,2500	2,00	MILANO	SC POLITICHE	17	,6873	,2850
4	BARI	GIURISPRUDENZA	16	2,2500	1,00	BOLOGNA	ECONOMIA	18	,6765	,2500
12	CAGLIARI	SC POLITICHE	16	2,2500	1,00	FERRARA	ECONOMIA	19	,6473	,2500
33	TORINO	ECONOMIA	17	2,2424	2,00	BOLOGNA	SC POLITICHE	20	,6208	,5450
23	TRENTO	ECONOMIA	18	2,2174	2,00	PISA	ECONOMIA	21	,6188	,0000
5	ROMA TRE	GIURISPRUDENZA	19	2,2000	1,00	Libera Università di BOLZANO	ECONOMIA	22	,6175	,4850
5	TORINO	LETTERE	19	2,2000	2,00	ROMA TRE	GIURISPRUDENZA	23	,6020	,1700
5	SANNIO DI BENEVENTO	SCIENZE ECONOMICHE	19	2,2000	1,00	TRENTO	ECONOMIA	24	,5996	,2500
8	politecnico di milano	INGEGNERIA	20	2,1300	2,00	CAGLIARI	SC POLITICHE	25	,5992	,2500
9	CHIETI-PESCARA	SC MANAGERIALI	21	2,1111	2,00	PIEMONTE ORIENTALE	SC POLITICHE	26	,5963	,4700
21	BRESCIA	ECONOMIA	22	2,0952	2,00	MACERATA	ECONOMIA	27	,5100	,2500

23	BARI	ECONOMIA	23	2,0870	2,00	"Parthenope" di NAPOLI	ECONOMIA	28	,4825	,2250
17	BERGAMO	ECONOMIA	24	2,0588	2,00	PALERMO	SC POLITICHE	29	,4800	,2500
26	FIRENZE	ECONOMIA	25	2,0385	2,00	FIRENZE	ECONOMIA	30	,4700	,1700
33	"Cà Foscari" di VENEZIA	ECONOMIA	26	2,0303	1,00	BRESCIA	ECONOMIA	31	,4690	,4400
22	MODENA e REGGIO EMILIA	ECONOMIA	26	2,0000	2,00	URBINO "	ECONOMIA	32	,4609	,2700
4	MILANO-BICOCCA	GIURISPRUDENZA	26	2,0000	2,00	TORINO	SC POLITICHE	33	,4597	,1000
5	MILANO-BICOCCA	SC STATATISTICHE	26	2,0000	1,00	NAPOLI "Federico II"	ECONOMIA	34	,4525	,0500
4	Cattolica del Sacro Cuore	SC. BANCARIE	26	2,0000	2,00	ROMA TRE	ECONOMIA	35	,4283	,0000
49	BOLOGNA	ECONOMIA	27	1,9796	1,00	PAVIA	ECONOMIA	36	,4280	,3000
36	Cattolica del Sacro Cuore	ECONOMIA	28	1,9722	1,00	Univ. del SALENTO	ECONOMIA	37	,4267	,4750
15	PAVIA	ECONOMIA	29	1,9333	2,00	FIRENZE	SC POLITICHE	38	,4208	,2250
34	TORINO	SC POLITICHE	30	1,9118	1,00	PADOVA	SC STATATISTICHE	39	,4171	,3700
9	MESSINA	ECONOMIA	31	1,8889	1,00	TORINO	GIURISPRUDENZA	40	,4144	,1000
9	MACERATA	ECONOMIA	31	1,8889	2,00	Cattolica del Sacro Cuore	SC POLITICHE	41	,4100	,1000
7	TERAMO	SCIENZE POLITICHE	32	1,8571	2,00	PISA	GIURISPRUDENZA	42	,4083	,2900
13	FOGGIA	ECONOMIA	33	1,8500	1,00	SANNIO DI BENEVENTO	SCIENZE ECONOMICHE	43	,4060	,1000
13	FIRENZE	ECONOMIA	34	1,8462	1,00	BERGAMO	ECONOMIA	44	,4041	,1000
16	"Parthenope" di NAPOLI	ECONOMIA	35	1,8125	1,00	Cattolica del Sacro Cuore	ECONOMIA	45	,4033	,1000
5	ROMA "Tor Vergata"	GIURISPRUDENZA	36	1,8000	,00	politecnico delle marche	ECONOMIA	46	,3868	,1350
18	MILANO-BICOCCA	ECONOMIA	37	1,7778	1,00	Cattolica del Sacro Cuore	SC. BANCARIE	47	,3850	,2500
4	CAMERINO	GIURISPRUDENZA	38	1,7500	,50	MESSINA	ECONOMIA	48	,3711	,0000
28	politecnico delle marche	ECONOMIA	39	1,7000	1,00	"Cà Foscari" di VENEZIA	ECONOMIA	49	,3682	,0000
9	SASSARI	ECONOMIA	40	1,6667	1,00	BARI	GIURISPRUDENZA	50	,3650	,0000
6	BOLOGNA	GIURISPRUDENZA	40	1,6667	2,00	VERONA	ECONOMIA	51	,3643	,1000
9	TORINO	GIURISPRUDENZA	40	1,6667	1,00	PISA	ECONOMIA	52	,3619	,1000
27	PISA	ECONOMIA	41	1,5926	1,00	SALERNO	ECONOMIA	53	,3541	,1700
17	SALERNO	ECONOMIA	42	1,5882	1,00	L'AQUILA	ECONOMIA	54	,3363	,0000
24	PISA	ECONOMIA	43	1,5417	1,00	TERAMO	SCIENZE POLITICHE	55	,3300	,2000
13	ROMA "La Sapienza"	SC STATATISTICHE	44	1,5385	1,00	SASSARI	ECONOMIA	56	,3278	,1000
23	VERONA	ECONOMIA	45	1,5217	1,00	MODENA e REGGIO EMILIA	ECONOMIA	57	,3095	,1150
4	"Parthenope" di NAPOLI	GIURISPRUDENZA	46	1,5000	1,50	"Parthenope" di NAPOLI	GIURISPRUDENZA	58	,2875	,2100
4	ROMA "La Sapienza"	INGEGNERIA	46	1,5000	1,50	UDINE	ECONOMIA	59	,2850	,2000
5	Università IUAV di VENEZIA	PIANIFICAZIONE del TERRITORI	46	1,5000	2,00	ROMA "La Sapienza"	ECONOMIA	60	,2822	,1000

		O								
4	MODENA e REGGIO EMILIA	SC COMUNICAZIONE	46	1,5000	1,00	PADOVA	GIURISPRUDENZA	61	,2688	,1500
4	MILANO-BICOCCA	SOCIOLOGIA	46	1,5000	2,00	MILANO-BICOCCA	SOCIOLOGIA	62	,2625	,1250
8	PERUGIA	SC POLITICHE	47	1,3750	1,50	NAPOLI "Federico II"	GIURISPRUDENZA	63	,2517	,0500
9	PAVIA	SC POLITICHE	48	1,3333	,00	PERUGIA	ECONOMIA	64	,2470	,0000
11	CASSINO	ECONOMIA	49	1,2727	1,00	ROMA TRE	SC POLITICHE	65	,2467	,2500
55	ROMA "La Sapienza"	ECONOMIA	50	1,2545	1,00	GENOVA	SC POLITICHE	66	,2375	,0500
28	NAPOLI "Federico II"	ECONOMIA	51	1,2500	1,00	CATANIA	SC POLITICHE	67	,2350	,0000
4	BERGAMO	INGEGNERIA	51	1,2500	1,00	Seconda Univ. NAPOLI	ECONOMIA	68	,2340	,2500
8	GENOVA	SC POLITICHE	51	1,2500	1,00	MILANO	GIURISPRUDENZA	69	,2167	,1000
24	ROMA TRE	ECONOMIA	52	1,2083	,50	MOLISE	ECONOMIA	70	,2067	,1000
5	Seconda Univ. NAPOLI	ECONOMIA	53	1,2000	1,00	BARI	ECONOMIA	71	,2004	,1000
6	Univ. del SALENTO	ECONOMIA	54	1,1667	1,00	Università IUAV di VENEZIA	PIANIFICAZIONE del TERRITORIO	72	,2000	,1000
8	L'AQUILA	ECONOMIA	55	1,1250	1,00	PERUGIA	SC POLITICHE	72	,2000	,1350
8	PADOVA	GIURISPRUDENZA	55	1,1250	,50	MILANO-BICOCCA	SC STATATISTICHE	72	,2000	,2000
17	CAGLIARI	ECONOMIA	56	1,1176	1,00	CAMERINO	GIURISPRUDENZA	73	,1950	,1150
10	NAPOLI "Federico II"	SC POLITICHE	57	1,1000	1,00	BOLOGNA	GIURISPRUDENZA	73	,1950	,0800
11	CHIETI-PESCARA	ECONOMIA	58	1,0909	1,00	CAGLIARI	ECONOMIA	74	,1882	,1000
11	SALERNO	SC POLITICHE	59	1,0909	1,00	MESSINA	GIURISPRUDENZA	75	,1875	,0000
6	MOLISE	ECONOMIA	60	1,0000	,50	MILANO-BICOCCA	GIURISPRUDENZA	76	,1800	,1500
10	PERUGIA	ECONOMIA	60	1,0000	,00	PALERMO	ECONOMIA	77	,1794	,0000
20	PARMA	ECONOMIA	60	1,0000	1,00	MODENA e REGGIO EMILIA	SC COMUNICAZIONE	78	,1775	,1900
4	MESSINA	SC POLITICHE	60	1,0000	,00	MESSINA	SC POLITICHE	79	,1750	,0000
4	della CALABRIA	SC POLITICHE	60	1,0000	1,00	CHIETI-PESCARA	ECONOMIA	80	,1655	,1000
5	"L'Orientale" di NAPOLI	SC POLITICHE	60	1,0000	1,00	PADOVA	SC POLITICHE	81	,1647	,0000
7	PISA	SC POLITICHE	60	1,0000	1,00	ROMA "La Sapienza"	SC POLITICHE	82	,1643	,0000
19	PADOVA	SC POLITICHE	61	,9474	1,00	PISA	SC POLITICHE	83	,1571	,1000
16	della CALABRIA	ECONOMIA	62	,9375	1,00	CASSINO	ECONOMIA	84	,1545	,1000
12	FIRENZE	SC POLITICHE	63	,9167	,50	SALERNO	SC POLITICHE	85	,1491	,1000
21	ROMA "La Sapienza"	SC POLITICHE	64	,9048	1,00	TUSCIA	ECONOMIA	86	,1357	,1000
10	UDINE	ECONOMIA	65	,9000	1,00	PAVIA	SC POLITICHE	87	,1333	,0000
10	CATANIA	SC POLITICHE	65	,9000	,00	ROMA "La Sapienza"	GIURISPRUDENZA	88	,1215	,0000
9	Cattolica del Sacro Cuore	SC POLITICHE	66	,8889	1,00	CATANIA	ECONOMIA	89	,1194	,0000
5	IULM - MILANO	SC COMUNICA	67	,8000	,00	della CALABRIA	SC POLITICHE	90	,1175	,1000

		ZIONE								
5	PALERMO	SC POLITICHE	67	,8000	,00	della CALABRIA	ECONOMIA	91	,1131	,0000
9	ROMA TRE	SC POLITICHE	68	,7778	,00	ROMA "La Sapienza"	INGEGNERIA	92	,1125	,1000
16	CATANIA	ECONOMIA	69	,7500	,00	MACERATA	SC POLITICHE	93	,1100	,0000
4	PAVIA	GIURISPRUDENZA	69	,7500	,00	GENOVA	ECONOMIA	94	,1100	,0000
12	NAPOLI "Federico II"	GIURISPRUDENZA	69	,7500	,00	CHIETI-PESCARA	SC MANAGERIALI	95	,1056	,0000
12	TRIESTE	ECONOMIA	70	,6700	1,00	PARMA	ECONOMIA	96	,1010	,0000
12	TRENTO	ECONOMIA	71	,6667	1,00	TRIESTE	ECONOMIA	97	,0942	,1000
16	PALERMO	ECONOMIA	72	,6250	,00	TRENTO	ECONOMIA	98	,0942	,1000
18	GENOVA	ECONOMIA	73	,6111	1,00	NAPOLI "Federico II"	SC POLITICHE	99	,0900	,0000
9	MILANO	GIURISPRUDENZA	74	,5556	1,00	ROMA "Tor Vergata"	GIURISPRUDENZA	100	,0880	,0000
20	ROMA "La Sapienza"	GIURISPRUDENZA	75	,5500	,00	"L'Orientale" di NAPOLI	SC POLITICHE	101	,0800	,0000
6	PISA	GIURISPRUDENZA	76	,5000	,00	BERGAMO	INGEGNERIA	102	,0675	,0500
8	BARI	SC POLITICHE	76	,5000	,50	TRENTO	SC POLITICHE	103	,0500	,0000
7	TUSCIA	ECONOMIA	77	,2857	,00	TRIESTE	SCIENZE POLITICHE	104	0,05	,0000
4	MESSINA	GIURISPRUDENZA	78	,2500	,00	FOGGIA	ECONOMIA	105	0,0462	,0000
5	MACERATA	SC POLITICHE	79	,2000	,00	FIRENZE	ECONOMIA	106	,0462	,0000
6	TRIESTE	SCIENZE POLITICHE	80	,1700	,00	"S. Pio V"	ECONOMIA	107	0	0
6	TRENTO	SC POLITICHE	81	,1667	,00	IULM - MILANO	SC COMUNICAZIONE	107	,0000	,0000
4	"S. Pio V"	ECONOMIA	82	,0000	0	BARI	SC POLITICHE	107	,0000	,0000