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Short communication

Comparing impact factors from two different citation databases: The case of Computer Science

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ABSTRACT

Journal impact factors continue to play an important role in research output assessment, in spite of the criticisms and debates around them. The impact factor rankings provided in the Journal Citation Reports (JCR™) database by Thompson Reuters have enjoyed a position of monopoly for many years. But this has recently changed with the availability of the Scopus™ database and its associated journal ranking published in the Scimago Journal Rank (SJR) Web page, as the former provides a citation database with similar inclusion criteria to those used in the JCR and the latter and openly accessible impact factor-based ranking. The availability of alternatives to the JCR impact factor listings using a different citation database raises the question of the extent to which the two rankings can be considered equally valid for research evaluation purposes. This paper reports the results of a contrast of both listings in Computer Science-related topics. It attempts to answer the validity question by comparing the impact factors of journals ranked in both listings and their relative position. The results show that impact factors for journals included in both rankings are strongly correlated, with SJR impact factors in general slightly higher, confirming previous studies related to other disciplines. Nonetheless, the consideration of tercile and quartile position of journal yields some divergences for journals appearing in both rankings that need to be accounted for in research evaluation procedures.

1. Introduction

The evaluation of research quality is of paramount importance for individual scientists, institutions assessing promotion and funding organizations and investors in general. The impact factor (IF) provided by Thompson Scientific (or Thompson Reuters) is a metric widely used for research evaluation purposes and included in their Journal Citation Reports (JCR™) database. The IF was proposed in by Garfield (1955) and reflects the frequency with which the journal's articles are cited in scientific literature. A journal's IF is the average of the number of citations in the current year to items published in the previous two years in that journal.

There has been considerable debate and criticism around the IF, especially considering that it does not capture all the important aspects required for the complex task of assessing the research output of individuals and groups (Opthof, 1997). Indeed, the IF covers only impact, and does it by considering a single, specific measure. Aspects potentially important that are not covered by the IF include, for example, usage metrics (Bollen, Van de Sompel, Smith, & Luce, 2005) or prestige (Habibzadeh & Yadollahie, 2008). Even though they do not provide a perfect tool as recognized by its proposer (Garfield,

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2006), impact factor rankings are still widely used worldwide for research evaluation, probably due to the fact that they provide a quantitative and cost-effective assessment method. Recent research has advanced in developing an axiomatic analysis of impact factors when used as tools for ranking journals (Bouyssou & Marchant, 2011). In consequence, it is worth the effort to continue analyzing and contrasting its validity.

For years, Thompson Reuters has been in a position of dominance as provider of impact factors, based on an established journal selection process and the regular maintenance of a considerably large citation database. But recently, an open alternative to the JCR has appeared (Butler, 2008a). The SJR (SCImago Journal Rank[1]) site offers journal rankings based on several measures of impact including the classical IF, but using Scopus™[2] as its data source rather than Thompson Reuters' citation databases. There are other open alternative citation databases as CiteSeer and Google Scholar, however these are very different in that they attempt to automatically index resources, following a very different approach to data collection and thus resulting in divergent quality and coverage figures (Jacsó, 2005).

The SJR indicator (Gonzalez-Pereira, Guerrero-Bote, & Moya-Anegon, 2010; SCImago, 2007) provided in the SJR site is a metric alternative to the IF which weights citations based on the impact of the citing journal. There have been some attempts to contrast the IF provided in the JCR with the SJR indicator (Lopez-Illescas, de Moya-Anegon, & Moed, 2008; Schopfel & Prost, 2009). However, the SJR indicator takes into account other elements that are not considered in the JCR IF, so that it can be hypothesized that it is measuring a different aspect of impact than the IF. The SJR site (not to be confused with the indicator of the same name) provides also the classical Garfield's IF metric available also in the JCR database, so that it is possible to contrast the same indicator as computed from two different citation databases. In consequence, we focus on classical IF for the comparison. This contrast is important for several reasons. From a theoretical perspective, it can be hypothesized that the same indicator computed separately from two different but homogeneous citation databases should yield similar rankings. If this is not the case in general, we can draw the conclusion that journal selection policies (or how these policies are applied) are significantly divergent, and the two rankings should not be used interchangeably. A similarity in the rankings also provides evidence on the lack of errors and bias in each of the databases, and citing based on that, the relative position of a journal in both listings when available can be considered as complementary evidence about the publication's impact. From a practical perspective, if the rankings result to be similar, any of the rankings can be used by researchers and evaluators as evidence of impact. This paper reports in a concrete study addressing the discipline of Computer Science, complementing existing related studies (Kimura, 2008; Lopez-Illescas et al., 2008; Schopfel & Prost, 2009). This can be extended to a contrast of different categories and disciplines, thus evaluating the coverage of the databases piecewise.

In order to compare both impact factor rankings, a number of issues need to be considered. The most important one is that journal coverage in JCR and SJR (Scopus) are not identical, as Scopus database is significantly larger in number of journals included. But ideally, similar rankings considering journal relative position would arise from the two, as both are using the same measures with two different samples and similar general journal selection criteria (Bühringer, Metzner, Lämmle, & Künzel, 2006). If the differences are not significant enough to affect potential assessment situations, then both computed rankings could be considered equally valid for research evaluation. This would represent the great benefit of having available a larger coverage of journals, considering both sources as complementary. A concern has been raised in the coverage of certain disciplines in either JCR or Scopus. For example, Togia and Tsigilis (2006) raised such concern for the field of education. Such divergences may result in significantly different IF distributions, so that coverage analysis is required on a discipline basis. However, in other disciplines, these concerns have not been raised to date and citation database contrast can be done under the assumption that journal selection have resulted in representative samples. A recent study by Lopez-Illescas et al. (2008) showed that for the field of oncology, the Web of Science (WoS) database (the citation database underlying Thompson Reuters JCR) is a genuine subset of Scopus, and tends to cover the best journals from it in terms of citation impact per paper.

This paper reports a study comparing impact factor rankings for the disciplines related to Computer Science in JCR and SJR. The study was carried out by extracting impact factor rankings of the last five years from both listings, and then evaluating their similarity, especially considering the common evaluation situation in which journal papers are assessed based on their relative position (e.g. terciles or quartiles). The results show that JCR and SJR rankings for the discipline of Computer Science show high significant linear correlations. Relative position analysis shows also high degrees of similarity with some exceptions that deserve further inquiry. Concretely, in a few cases, if quartiles are used to evaluate journal relative position, JCR and SJR may lead to different results, and this needs to be carefully considered.

The rest of this paper is structured as follows. Section 2 reports the data collection, preparation and basic descriptive statistics. Then, data analysis and hypotheses testing together with results discussion are provided in Section 3. Section 4 discusses limitations of the study and Section 5 provides conclusions and outlook.

2. Data gathering and descriptive analysis

Two-year impact factors were obtained from Computer Science subject categories from 2004 onwards, both from the JCR and from the SJR Web interfaces[3] and a relational database was developed following a similar design as Mallig (2010). The

[1] http://www.scimagojr.com/.
[2] http://info.scopus.com/.
[3] At the time of the writing of this paper, the last year available in both listings was 2008.

Table 1
Size of each of the subject categories from 2004 to 2008.

ISI JCR categories	2004	2005	2006	2007	2008
COMPUTER SCIENCE, ARTIFICIAL INTELLIGENCE	78	79	85	93	94
COMPUTER SCIENCE, CYBERNETICS	18	18	18	17	17
COMPUTER SCIENCE, HARDWARE & ARCHITECTURE	44	44	44	45	45
COMPUTER SCIENCE, INFORMATION SYSTEMS	78	83	87	92	99
COMPUTER SCIENCE, INTERDISCIPLINARY APPLICATIONS	83	83	87	92	94
COMPUTER SCIENCE, SOFTWARE ENGINEERING	76	79	82	84	86
COMPUTER SCIENCE, THEORY & METHODS	70	71	75	79	85
	447	457	478	502	520

SJR categories	2004	2005	2006	2007	2008	Totals
COMPUTER SCIENCE, INFORMATION SYSTEMS	75	77	88	104	115	121
COMPUTER SCIENCE, ARTIFICIAL INTELLIGENCE	77	79	81	85	87	92
COMPUTER SCIENCE, COMPUTATIONAL THEORY AND MATHEMATICS	106	110	113	117	121	123
COMPUTER SCIENCE, COMPUTER GRAPHICS AND COMPUTER-AIDED DESIGN	58	59	63	66	67	68
COMPUTER SCIENCE, COMPUTER NETWORKS AND COMMUNICATIONS	78	82	89	97	105	117
COMPUTER SCIENCE, COMPUTER SCIENCE (MISCELLANEOUS)	57	66	80	93	101	108
COMPUTER SCIENCE, COMPUTER SCIENCE APPLICATIONS	80	87	90	104	125	149
COMPUTER SCIENCE, COMPUTER VISION AND PATTERN RECOGNITION	27	28	29	31	34	35
COMPUTER SCIENCE, HARDWARE AND ARCHITECTURE	101	101	101	108	116	118
COMPUTER SCIENCE, HUMAN-COMPUTER INTERACTION	19	19	20	22	24	26
COMPUTER SCIENCE, SIGNAL PROCESSING	25	27	27	32	39	41
COMPUTER SCIENCE, SOFTWARE	125	127	129	134	147	157
	828	862	910	993	1081	
Number of journals appearing in both rankings	222	229	238	251	259	

journals considered were those using “Computer Science” as a prefix in the name of subject categories (in the case of the JCR), and those classified under “Computer Science” as “Subject Area” in the case of SJR. It should be noted that this selection might not cover all the journals that researchers in what is often called “computing” publish their papers. Particularly, there are a significant number of interdisciplinary or applied research journals that are probably not considered in our selection. However, the difficulty of defining a clear criterion for inclusion has led us to consider only these journals explicitly labelled as “Computer Science” journals.

The categories in both databases have a considerable degree of overlap in category names, with SJR categories appearing as a superset, with the exception of the CYBERNETICS category, a small sized category appearing only in the JCR. It is worth noticing that journals staying at the disciplinary boundaries of computing are covered in the categories COMPUTER SCIENCE, INTERDISCIPLINARY APPLICATIONS in JCR and COMPUTER SCIENCE (MISCELLANEOUS) in SJR.

Table 1 summarizes the categories considered and number of journals in each for the period of the last five years. It should be noted that the categories at each database are overlapping due to multiple classifications. The incidence of poli-classifications (journals appearing in more than one category) is in general low. In the JCR, the average number of classifications was 1.28 in 2004, slightly increasing progressively up to 1.31 in 2008. In SJR, it starts with 1.41 in 2004 and remains stable up to 2008. In consequence, the impact of multiple classifications can be considered comparable in both databases.

Table 1 shows some initial differences in the size of the ranking lists, with SJR approaching two times the size of JCR listing, considering occurrences of journals in categories. In addition to that, grow rates in the years considered in JCR range in 2–4%, while in SJR are in the range 4.1–9.1%. In Table 1 an additional column in the left is included for each SJR category. It contains the size reported in the rankings that appear in the SJR site at the time of this writing, which is equal for each category for all of the years. This is probably because the rankings published on-line consider all the journals in the category and not those included that year. To obtain more realistic figures, journals in each year with zero citable documents such as editorials or letters to the editor for that year were filtered out, resulting in the figures reported in the rest of the columns in the table for the SJR. Note that these numbers are lower even in the last year, probably reflecting journal inclusions to occur in the coming year.

This in general reflects a larger size in SJR, which is consistent with the fact that the database is said to cover significantly more journals than its Thompson Reuters counterpart.

The last row of Table 1 shows the number of journals appearing in both rankings per year, obtained comparing journal names. As it can be noted, it is stable around a 50% of the coverage of JCR (the smaller of the two rankings), considering journals occurrences in categories. If we consider journals independently of category occurrences, the coverage of JCR is higher, e.g. in 2008 there are 394 journals in JCR in the Computer Science subject category combined, so that 65% of the journals are appearing in both listings. This shared core of journals will be used as the point of departure for our present research, as it provides the basis for contrasting both rankings with respect to the relative positions of journals. Ideally, journals in both rankings would stay at the relative position—e.g. at the same quartile. It should be noted also that in the SJR,

Table 2
Basic descriptive statistics for the common subset of journals.

	2004	2005	2006	2007	2008
Average IF (JCR)	1.13	1.21	1.11	1.09	1.43
Average IF (SJR)	1.57	1.78	1.71	1.7	1.68
Standard deviation IF (JCR)	1.17	1.04	0.92	0.83	1.15
Standard deviation IF (SJR)	1.58	2.56	1.59	1.46	1.45
Maximum difference SJR–JCR	5.85	6.48	6.0	7.0	5.4
Minimum difference SJR–JCR	−2.12	−1.29	−0.96	−1.2	−3.54
Average difference SJR–JCR	0.43	0.57	0.6	0.61	0.25
Standard deviation difference SJR–JCR	0.73	0.78	0.7	0.83	0.61

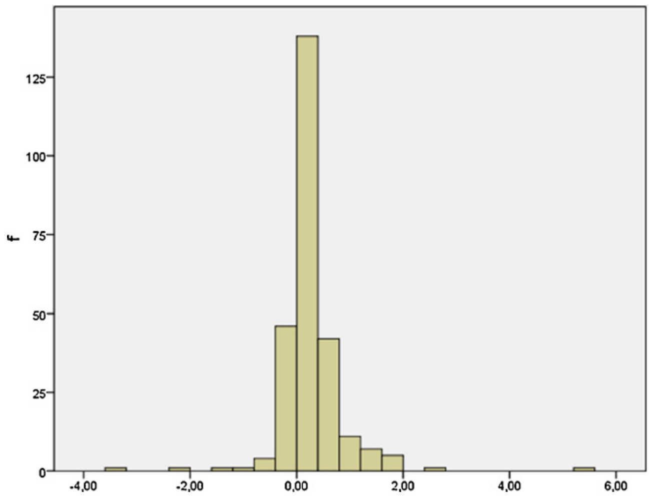

Fig. 1. Histogram for differences SJR–JCR for common journals.

some publications that are actually conference proceedings appear in the rankings. These publications represent around a 5% of the database, so that we have decided to retain them in the analysis, especially given the fact that high quality conferences are considered to be important research output sources in Computer Science, some of them comparable to scholarly journals in their degree of prestige and competence (Coyle et al., 2008), and conference rankings have started to gain wide acceptance (Butler, 2008b). Conference papers in Computer Science have been found to be cited significantly less than journal articles (Franceschet, 2011), but in general prestigious conferences can be considered together with journals.

Table 2 provides basic descriptive statistics for the common core of journals.

Data in Table 2 is consistent with the findings by Lopez-Illescas et al. (2008) regarding a moderate positive difference of the impact factors using Scopus, which could be attributed to the larger size of the journal database.

Fig. 1 shows the histogram of the differences between the impact factors in SJR and JCR, showing that most of them concentrate around zero. A histogram relative to JCR impact factors retains the same distribution. Absolute differences are larger for higher impact factors—i.e. differences and JCR impact factors correlate positively (0.22 using a Spearman correlation rank with alpha 0.01 for 2008 data). The larger absolute difference for 2008 affects ACM COMPUTING SURVEYS (5.4 contrasting with the second larger difference of 2.43), but this can be considered a special case, as survey journals are known to attract more citations, and they may be consequently more sensitive to journal database size. Relative differences are high for some journals, being the larger in 2008 for COMPUTER COMMUNICATION REVIEW (2.53). However, there are only seven journals with a relative difference higher than 1.

It is noticeable also that the distributions of impact factors in both listings appear to follow a similar distribution as can be appreciated in the histograms depicted in Fig. 2 (similar distributions can be found for all the years considered). However, the Mann-Whitney W test shows statistical differences in the medians and the Kolmogorov–Smirnov test reports statistical differences in the distributions at confidence levels of 1% for year 2004 (top part of Fig. 2. But at the same level, there is no statistical difference in the median for 2008 data (bottom part of Fig. 2). Distribution analysis is thus inconclusive regarding the similarity of the distributions, but they follow a common pattern in all years, showing an increasing slope up to an impact factor level around one, and then a progressive decrease.

In general, there are very few journals with high impact factors, e.g. above 4. For example, in 2008 the 95% percentile is at 3.6 for JCR and for SJR at 4.17.

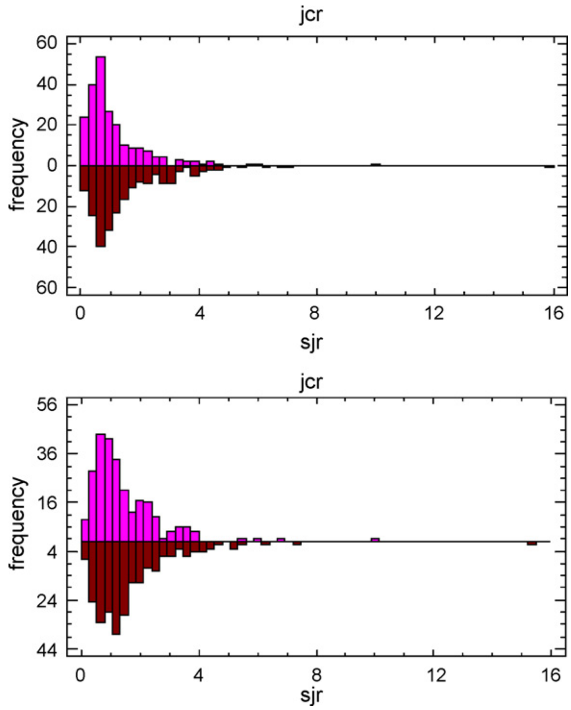

Fig. 2. Histogram comparison JCR/SJR for common journals in 2004 (top) and 2008 (bottom).

Table 3
Correlation and linear regression parameters between JCR and SJR per year.

	2004	2005	2006	2007	2008
Spearman's rho at 0.01	0.9	0.9	0.9	0.9	0.93
Linear regression parameter a	1.35	1.47	1.56	1.53	1.15
Linear regression parameter b	n.s.	n.s.	n.s.	n.s.	n.s.
Linear regression R^2	0.85	0.84	0.82	0.74	0.83

3. Contrast and discussion

The relation of the impact factors of the journals covered by both listings was analyzed using the non-parametric Spearman's rank correlation coefficient, and also performing linear regression. Results are provided in Table 3.

Results show a strong significant correlation between the impact factors in JCR and SJR, again with similar figures as those reported by Lopez-Illescas et al. (2008) for oncology. This can be considered significant evidence in favour of considering both citation databases as equally valid to assess the impact factor of journals. As the two different citation databases are yielding correlated impact factors, relative positions of journals in the rankings can be considered to be comparable.

Linear regression was used to evaluate the correlation of both impact factor rankings per year. Table 4 reports the linear correlation coefficients obtained ('n.s.' stands for 'non significant'). Coefficients of determination are high in all the cases. This indicates that a linear model is capable of representing the relationship between the two measures. In year 2008, there is an alternative, better higher order model with $R^2 = 84.3$. The curve is shown in Fig. 3.

The last analysis concerned the relative position of journals appearing in both indexes as it is usually considered in assessment, i.e. by considering terciles or quartiles. Quartiles were used for a more fine grained analysis. For each year, the quartiles in both of the indexes were computed and then the journals coinciding were selected.

Table 4 shows that about half of the journals are classified in the same quartile in both rankings. When considering zero or one quartile of difference, the remaining classification errors decrease dramatically to a small percentage. In 2008 and 2007,

Table 4
Differences in relative positions in both listing on common journals.

	2004	2005	2006	2007	2008
Percentage of coincidence in quartile	60%	68%	55%	50%	49%
Coincidence considering one quartile of difference	96%	98%	97%	95%	97%

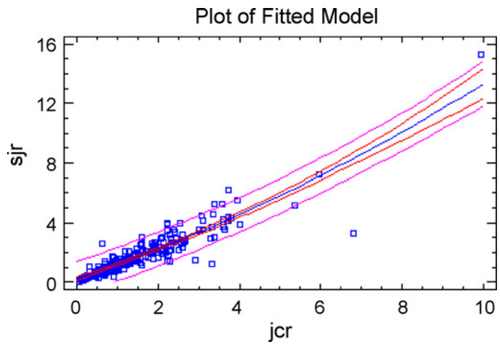

Fig. 3. Higher level model for 2008 data.

COMPUTER COMMUNICATION REVIEW was the only journal with a difference of three in the classification. Concretely, it was classified in Q4 at JCR and in Q1 at SJR. In 2006, the same happened only to ACM TRANSACTIONS ON DESIGN AUTOMATION OF ELECTRONIC SYSTEMS, which exhibits a peak in 2006 SJR impact factor. In 2004 and 2005 there are no distances of three quartiles in classification. Two important conclusions can be drawn from this analysis. First, wide differences in relative position are scarce. But the second conclusion is that the difference of position in adjacent quartiles is not significant, as these differences account up to 51% some years. This has important consequences for research assessment based on relative position that need to be accounted for. An interesting analysis is that for all the years, most of the cases in which quartile differences exist correspond to a situation in which the JCR quartile position is lower than the corresponding SJR quartile position for the same journal. Concretely, it amounts to 87% of the cases in 2004, 95% in 2005, 95% in 2006, 92% in 2007 and 96% in 2008. In consequence, it is more likely that a journal in the SJR ranking will be in a higher quartile than in the JCR.

Coincidences are higher considering terciles. For 2008, only two journals differ in more than a tercile of distance, COMPUTER COMMUNICATION REVIEW and INFORMATION RETRIEVAL, both better positioned in SJR. However, Spearman correlation coefficient between the classification in terciles is 0.78 and 0.85 for quartiles, which are still significant enough to be considered as evidence favouring the interchangeable use of both rankings. Also interestingly, there are only 5 cases in which the quartile in SJR is worse than the quartile in JCR, all of them ranked in the first quartile in JCR.

4. Limitations

Subject categories in both JCR and SJR are broad categories without a clear definition of the contents covered. Indeed, many journals are cross-cutting several of the categories listed, and classification is often challenging (Leydesdorff & Rafols, 2009). A broader definition of computing could have covered for example journals in the category of "Medical informatics". The discrimination of the "Computer Science" discipline by using the top level breakdown of both rankings was selected as a reasonable approach to avoid a too broad inclusion criterion that might have combined research communities with differing citation patterns together. However, it has the drawback of filtering out journals appearing in both citation databases. The authors were unable to find a criterion that resulted in a higher degree of coherence and a larger percentage of journals appearing in both selections. It should be noted that the heuristic methods used by Thompson Scientific for categorizing journals are considered by Garfield as imperfect, even though citation analysis informs their decisions (Garfield, 2006). However, there are no alternatives available for perfect categorization.

Another limitation of the research presented here is that both citation databases are continuously evolving, as can be seen in the evolution of number of journals presented in Table 1. As a consequence, data reported here might become obsolete if journal coverage is expanded significantly in the future.

The study is also limited to impact factors, but correlations of other measures have been reported in the literature. For example, Serenko (2010) reported on correlations between h-index, g-index, and hc-index and Thomson's Journal Impact Factors for the field of Artificial Intelligence.

5. Conclusions and outlook

The results of the contrast of classical impact factors in JCR and SJR listings for the discipline of Computer Science confirm that in spite of the differences in the underlying citation databases, they are highly correlated and yield comparable rankings. This can be used as evidence supporting the hypotheses that both rankings are similarly valid for research assessment, as they will point to similar relative journal impact assessments when approaching research output evaluation. It should be considered that SJR impact factors are in general higher than JCR ones (this is probably an effect of the larger underlying journal database, but this is irrelevant to our objectives here), so that some kind of correction factor can be used if we want to extrapolate SJR impact factors for journals not listed in ISI Thompson databases.

However, the resulting rankings can only be comparable when considering a classification error of one quartile or tercile, as there are an important number of journals that are classified in SJR one quartile (or tercile) above the classification they have in the JCR. This effect in the final relative position deserves further exploration as assessment usually takes place considering either terciles or quartiles. Research assessment panels or committees should therefore accept SJR impact factors as an evidence of quality but also clearly elaborate criteria if both JCR and SJR quartiles are going to be used together in the same process.

The results described here are specific to a particular disciplinary area that is covered by JCR and Scopus. In consequence, it might be that the results obtained are not valid for other disciplines. Further research should repeat similar methods for all the disciplinary areas covered by the citation databases, looking for confirming or disconfirming the hypothesis that JCR and SJR impact factor rankings can be used interchangeably.

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