The use of Cited Half Life to assess obsolescence evolution in different research domains: an empirical test

UGO FINARDI, ISABELLA BIANCO

CNR-IRCrES, National Research Council, Research Institute on Sustainable Economic Growth, via Real Collegio 30, Moncalieri (TO) – Italy

corresponding author: ugo.finardi@ircres.cnr.it

ABSTRACT
Among the bibliometric indicators dealing with ageing of scientific literature, Cited Half Life (CHL) has a relevant position, as stated by ISI-WoS. The present work aims at performing an empirical test of the different features of CHL with particular regard to its evolution in the two domains of Sciences and Social sciences in ISI-WoS. For this purpose, first a sample of Subject categories is extracted. Then, mean and median for every year from 1999 onwards are calculated. Finally, trends and non-parametric correlation coefficients for all the values are obtained. The aim is to devise whether strong differences exist between the two domains, and surreptitiously to assess the meaningfulness of the use of CHL as an indicator of ageing of scientific literature. At the end of the paper the results are described and, accordingly, conclusions are drawn.

KEYWORDS
Cited Half Life; obsolescence; citation ageing; citation trends; Sciences; Social sciences; Linear regression; Spearman's ρ.

JEL codes: O32; I23

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1. INTRODUCTION

How and how much scientific products are cited by others across time, as well as the ageing of scientific literature are core topics in bibliometric studies since their beginning. Citations are generally considered as the most relevant indicator of the impact of scientific literature, and thus their trends are regarded as a way to measure the obsolescence of the knowledge contained in a scientific product.

A wide body of literature studies how citations evolve over time, aiming also at introducing indicators that help measuring changes across time in the citedness of articles, journals or sectors. The research questions related to this topic are of various kind. These range from measurement of the ageing in single fields or journals, to the comparison between different areas and to the elaboration of metrics to evaluate knowledge ageing and to exploit it for practical use, such as making decisions for the management of libraries. “Ageing” is here defined as obsolescence of scientific literature measured with the decay of the number of received citations of a set of scientific products.

Recent findings (Finardi 2014) show that differences exist between different ISI Subject categories in the time evolution of the mean number of received citations per article. In particular, the cited empirical study has been conducted on Subject categories belonging to two different domains (namely “Chemistry, multidisciplinary” from ISI Science Edition and “Management” from ISI Social Science edition). From these findings, a further question may arise on whether or not other indicators might be able to explore differences of ageing across different domains and whether bibliometric metrics could be tested for this specific purpose.

Among the existing metrics, 0043ited Half Life (CHL from now on) is one of those having more strict connection with ageing of scientific literature. The website of ISI Web of Knowledge® (where CHL is reported) defines Journal CHL as follows: “The Cited Half-Life is the median age of the citations received by a journal during the JCR year. […] By definition, half of a journal's earned citations are to items published before the Cited Half-Life, and half are to items published after the Cited Half-Life. […] Studying the half-life data of the journals in a comparative study may indicate differences in format and publication history”[1].

This last suggestion is one of the drivers of the present work, which aims at testing if CHL of Subject categories belonging to different scientific domains is a sensible means to measure differences in ageing. In particular, what we do is measuring the evolution over time of aggregate values (mean and median) of CHL. The trends of the two values – increasing, decreasing, or remaining stable – should in principle offer an outlook on how the ageing of received citations evolves over time. In this way, changes in ageing should theoretically be put in evidence.

Summing up, the present article tries to answer to the following research question: do different scientific domains present different evolution of ageing according to the evolution of their CHL? To seek a response to this question this work performs an empirical analysis on the evolution of the CHL aggregate values of a sample of ISI Subject categories in both Thomson Reuters – ISI Web of Knowledge® JCR domains: Science and Social Sciences Editions. It is expected that the CHL values for the two domains evolve differently over time. In fact, the above cited results of Finardi (2014) show different trends in the evolution of received citations for a sample of journals from a Subject category belonging to the Science domain (Chemistry) and for those included in a Social science Subject category (Management). This difference – if confirmed – should in principle be able to clarify different ageing tendencies. A growing trend of aggregate values of CHL should mean that the Subject category is facing a growth in ageing. In this case older papers tend to be more and more cited over time. On the contrary, a decreasing CHL trend should indicate a reducing of ageing: newest papers are more cited than older ones.

[1] http://ipscience-help.thomsonreuters.com/incitesLiveJCR/JCRGroup/jcrJournalProfile/jcrJournalProfileCitedJournal.html (link consulted July 2017).

Moreover, the analysis performed in the present work might be able to surreptitiously offer further evidence to other related problems. In fact in the past CHL has been defined an "inappropriate measure of impact decline" (Moed et al. 1999). Thus, we try to explore more in deep the nature of this indicator, seldom studied in recent years also in order to better frame its use and add evidence to the meaningfulness or not of its potential exploitations. also for practical purposes.

Given the intrinsic nature of the underlying dataset – a sample of Subject categories, and a forcedly limited number of years encompassed – this work does not neither claim to be conclusive, nor to fully clarify the nature and characteristics of CHL. Nevertheless, it is our opinion that, also due to a smaller number of works on the topic of CHL, this study can be a small but important step to start exploring this specific sub-topic.

The article is organized as follows. Section 2 contains a literature review, describing previous studies on the more narrow topic of CHL. Section 3 presents the methodology used to build the database and to analyze it. Results are presented in section 4, while fifth and last section contains the conclusions.

2. Literature review: features and use of CHL

The present literature review deals mainly with the nature and the use of Cited Half Life, trying to focus on the specific topic of the article. Thus, we do not review literature on the more general topic of obsolescence and ageing of scientific literature, which is very vast and would drive this framework out of its purpose. The corpus of literature discussing CHL, instead, is not huge, and most relevant contributes can be briefly discussed.

A first group of works deals with the features of CHL. Moed et al. (1998) and Moed et al. (1999), in their studies on different indicators of ageing and impact of scientific production, critically discuss CHL. In particular, they calculate a Corrected CHL (CCHL), defined as "the (estimated) time period in which the average impact is reduced by a factor of two", correcting "for the differences in the numbers of documents published per year" (Moed et al. 1998: 395 passim). According to their results, CHL and CCHL differ markedly, as in only about 25 % of the journals they are equal or almost equal. This outcome is due to two factors: the first one is that "CHL is determined both by the rapidity of maturing as well as the speed of decline, while CCHL relates to the decline phase only". The second is the fact that "ISI does not correct for changes in the number of documents per year" (Moed et al. 1998: 413 passim).

In a paper discussing a similar topic, however, Leydesdorff (2008) shows instead that journals publishing specific categories of articles (i.e. Letters and Reviews) present a peculiar distribution of CHL in citation behavior among disciplines. In fact, subsequently Leydesdorff (2009) again notes that: "this indicator enables us to distinguish different expected citation behaviors among sets based on different document types (articles, reviews, and letters) independent of the differences" (Leydesdorff 2009: 1334) and that "the cited half-life provides a separate dimension for the evaluation" (Leydesdorff 2009: 1334) with respect to other indicators".

Besides the above reported discussion on the features of CHL, some other works discuss the use of CHL for the practical purposes it was introduced for (together with other indicators): helping librarians in making strategic choices towards subscriptions. It is the case, for instance, of the work of Ladwig and Sommese (2005). The authors devise a methodology to exploit CHL to correct the download statistics of scientific articles. CHL is used here as an indicator of the ageing of scientific journals. This use in turn should help librarians to optimize the use of resources for library subscription, by performing cancellation decisions. Also Takei et al. (2013) propose an analysis of the use of electronic journals, collecting usage data from a Japanese University. Authors use Impact Factor and CHL as well as download indexes, to measure "faster" (IF) and "slower" (CHL) obsolescence. Their results show long obsolescence values for "Mathematics and statistics" and "Behavioral Science" with respect to other natural science fields (p. 1781).

Moreover, CHL has been used also for other practical purposes. Sjøberg (2010) compares obsolescence in computing research with that of other research fields, using CHL, as well as Citing half-life, to find that "the ageing of the computing literature is not atypical compared with other scientific research disciplines" (Sjøberg 2010: 66). Also Della Sala and Crawford (2006; 2007) analyze CHL for a specific practical goal, that is, showing that the discipline of neuropsychology is penalized by the 2-years window of Impact Factor. The "dissociation" between IF and CHL shows, according to the authors, that "clinical journals and neuroscience journals have a much faster turnover than classic neuropsychology" (Della Sala and Crawford 2007: 43).

Finally, it should be noted that the topic of CHL has been tackled also by authors interested in methodologies rather than in application of results (see for instance Hsu & Huang, 2011).

This brief literature overview encompasses a relevant selection of literature on the topic of CHL, which, as above described, is not very huge at present. This lack of significant dimensions leaves space for further research that we try to fill partly with the present contribution.

3. METHODOLOGY

Data extraction activity for this work has been performed exploiting the version of ISI Journal Citation Reports available at CNR – National Research Council of Italy. The first step has been the choice of a sample of Subject categories out of the 172 categories of the "Science Citation Index" and of the 55 categories of the "Social Science Citation Index". The chosen Subject categories are listed in Table 1. 10 Subject categories have been selected in the "Science Citation Index" and 4 in the "Social Science Citation Index". The numbers of Subject categories have been chosen in order to respect the proportion between the two groups of Subject categories.

The choice of Subject categories to be included in this study has been performed trying to cover as much as possible the content of the two Indexes. Thus in "Science", preference was given to the research areas of Agriculture, Biology, Chemistry, Computer sciences, Engineering, Geosciences, Materials sciences, Mathematics, Physics, choosing the Subject areas listed in the table. In particular, when present, the "MULTIDISCIPLINARY" subject category relative to the area has been chosen, trying to represent its more general character. In addition, a further most general Subject category, MULTIDISCIPLINARY SCIENCES, has been included. Also in "Social sciences" the choice has been oriented towards covering different scientific areas. This reasoned choice has been performed in order to better represent the two Research Domains, always noting that this work stands only as an empirical test

After choosing the 14 categories included in the study, data related to the journals in the Subject categories have been extracted from ISI-WoS for all the years from 1999 to 2013. The main set of data contains the values of CHL of all the journals in each Subject category. Furthermore, also information on the number of journals in the category for the specific year, the number of published articles and the number of total received citations have been gathered. It should be noted that some of the chosen categories start being considered in ISI-WoS not in 1999, but in 2000 (AGRICULTURE, MULTIDISCIPLINARY; CHEMISTRY, MULTIDISCIPLINARY; ENGINEERING, MULTIDISCIPLINARY; MATERIALS SCIENCE, MULTIDISCIPLINARY; PHYSICS, MULTIDISCIPLINARY) or in 2001 (MATHEMATICS, INTERDISCIPLINARY APPLICATIONS; PSYCHOLOGY, MULTIDISCIPLINARY). Another relevant point to be underlined is related to the way CHL is expressed in ISI-WoS. Values of CHL are integers going from 1 to "> 10", meaning that in this case CHL is equal or above 10. Such values have been forcedly counted as 10 (max value) in the below described calculations. Out of the data obtained from ISI-WoS mean and median for every year and every Subject category have finally been calculated.

4. RESULTS

Tables 2a, 2b (Science) and 3 (Social science) contain the dataset obtained from ISI-WoS for each year and Subject category. Reported data are: Mean CHL, Median CHL, Number of journals in the category, Number of articles in the category, Total received citations.

A simple linear regression has been performed for all the series of means and medians. The obtained trend lines are an indicator of the evolution of such trends. Table 3 contains the values of the coefficients and the values of R^2 for each Subject category and for both Mean and Median.

The meaningful values are those of the linear coefficients “a” of the equation, which in this case can tell if the trend is growing (positive values) or decreasing (negative values) over time. Coefficients should be considered together with the values of R^2. It is easy to notice that the results are rather mixed, especially with regard to R^2. We thus consider as meaningful the values of R^2 above 0.5. Such values are shaded in Table 3. Concerning angular coefficients, the negative ones are in italics and the positive ones in bold. Table 3a synthetizes the results, considering only the equation presenting with $R^2 > 0.5$. Almost half of the results present a value of $R^2 > 0.5$: 9 in Sciences (5 means and 4 medians) and 4 in Social sciences (2 means and 2 medians).

Table 3 shows that, out of the 10 Subject categories in Science, 3 present both (mean and median) positive angular coefficient, while 7 present a negative one. Considering Social science, all the coefficients are positive, but for one case. Table 3a shows more precisely the results considered more meaningful, due to the value of R^2. It is easily seen that, among the 9 angular coefficients of Science Subject categories, only 2 are positive (a mean and a median). It must also be noted that the represented Subject categories are 6, as for 3 of them only one of the two best-fit lines has $R^2 > 0.5$. When coming to the results of Social science Subject categories, all the 4 values are positive and belong to two of the categories in the sample.

In order to explore the features of CHL Spearman’s ρ rank correlation coefficients have been calculated for all the trends of means and medians against the succession of years. This has been done to test whether there is or not a monotonic correlation of trends with their time evolution. The results are reported in tables 4 and 4a. Table 4a reports only those values having $P < 0.05$ (the null hypothesis tested is H0: $\rho = 0$). It is easily seen that the results are comparable with those reported above. Almost all the meaningful correlations are strong or even very strong.

Finally, for sake of completeness another best fit has been calculated. Values of mean and median of CHL have been plotted against the number of articles published in the Subject category in the corresponding year. The rationale for this is the above cited results of Moed et al. (1998), who correct CHL “for the differences in the numbers of documents published per year” (Moed et al. 1998: 395). Thus, the curiosity arose to check whether there is a correlation between the aggregate CHL value and the number of published articles. Results of this analysis are reported in Tables 5 and 5a, with the same method exploited above. The result is similar to that of the above described best fit, though less values are meaningful. Nevertheless, this result should be taken ever more carefully. In fact, data presented in tables 2 and 3 show that the number of articles per Subject categories grows more or less steadily with time for all considered Subject category. Thus, it should be concluded that this analysis can’t tell explicitly the presence of a correlation between aggregated values of CHL and the number of articles.

5. Discussion of results and conclusions

Aim of the present article is to test empirically whether the evolution across time of CHL presents different features in different scientific areas or not. Surreptitiously, this analysis tries to deepen the use of CHL as an indicator of ageing. That is, it aims at adding evidence on the effectiveness of the use of CHL in the assessment of differences in the ageing of scientific literature in different scientific fields.

The present study is only a preliminary empirical test, and does not claim to be conclusive in answering to its general questions. It is based on a meaningful sample of scientific literature and the time span it encompasses is forcedly limited to a time series of 15 years. Nevertheless, even with the above mentioned data limitations, this research contributes to understand the specific features of CHL that have been seldom explored to the best of our knowledge.

Though we do not claim that results are conclusive, they nevertheless show a tendency, or a general trend, leaving space for further research and empirical analyses. In fact, it is easily shown that most of the significant ($R^2 > 0.5$) trends of both mean and median in Sciences present a negative angular coefficient. This means that the aggregate measures of CHL in the Science categories in the sample mostly decrease from 1999 to 2013. This in turn depends from the fact that citations received by journal articles in the category point increasingly over time to more recent journals.

If instead we consider Social sciences, we see mostly an opposite behavior. All the angular coefficients of the four significant ($R^2 > 0.5$) trends (mean and median of two Subject categories) are positive. This is also true for seven out of eight of the total angular coefficients. Thus, in the case of Social science, aggregate mean and median CHL tend to grow over time, indicating a higher degree of ageing of Social Sciences Subject categories.

Results offer an insight on the relations between CHL and ageing. Data show – even if not so evidently – that Science and Social science Subject categories, encompassed in the sample, present differences in the evolution across time of the aggregate indicators (mean and median). These differences are paired with the above introduced results of Finardi (2014) obtained on two of the Subject categories also considered in the present study. Nevertheless, it must be noted that the indicator used in that work (received citations) is more effective than CHL in measuring obsolescence of a scientific field. Conversely, CHL, being itself a complex indicator, allows obtaining results with a lesser effort of data elaboration.

Summing up, results show that Subject categories from "Science Citation Index" face a slight process of "rejuvenation". That is, it is possible to witness a trend of citation of publications that are becoming younger and closer in time to the citing document. Conversely, those Subject categories that are encompassed in "Social Science Citation Index" face an opposite dynamic, citing along time in average publications that are older. These fact might be due, by one side, to the increasing speed of research in sciences and on the other side, to the persistence of "classics" that continue being cited notwithstanding (or probably due to) their age.

Summing up results from the methodological perspective, this work can offer only partial evidence about the "appropriateness" of the use of CHL as an instrument to assess obsolescence of citation in scientific field. In fact, while results of Finardi (2014) are rather evident in their outcome, results obtained with the use of CHL, though showing a different behavior between different areas, do not present such a marked difference. Thus, by one side our results can't be deemed as conclusive; on the other side we can affirm that they do not support clearly the practical use of CHL to assess differences in "impact decline" existing between different fields.

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7. APPENDIX

Table 1. Subject categories included in the study

SCIENCE CITATION INDEX	
	AGRICULTURE, MULTIDISCIPLINARY
	BIOLOGY
	CHEMISTRY, MULTIDISCIPLINARY
	COMPUTERSCIENCE, INTERDISCIPLINARY APPLICATIONS
	ENGINEERING, MULTIDISCIPLINARY
	GEOSCIENCES, MULTIDISCIPLINARY
	MATERIALSSCIENCE, MULTIDISCIPLINARY
	MATHEMATICS, INTERDISCIPLINARY APPLICATIONS
	MULTIDISCIPLINARY SCIENCES
	PHYSICS, MULTIDISCIPLINARY
SOCIAL SCIENCE CITATION INDEX	
	EDUCATION & EDUCATIONAL RESEARCH
	INTERNATIONAL RELATIONS
	MANAGEMENT
	PSYCHOLOGY, MULTIDISCIPLINARY

Table 2a. Dataset, Science Citation Index

SCIENCE CITATION INDEX	YEAR	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
AGRICULTURE, MULTID.																
	MEAN CHL	-	8.5	8.1	7.9	7.9	8.0	8.0	7.9	7.5	7.4	7.1	6.6	6.4	6.2	6.4
	MEDIAN CHL	-	10.0	9.1	8.9	9.0	9.2	8.7	7.1	7.4	6.8	7.0	6.6	6.6	6.0	6.4
	N. JOURNALS	-	28	28	28	29	29	31	31	35	35	45	55	57	57	56
	N. ARTICLES	-	2,832	2,592	2,884	2,947	2,813	3,633	3,865	4,120	4,587	4,752	5,859	6,068	6,025	6,353
	TOT. CITES	-	37,248	39,018	44,030	48,307	52,735	59,918	68,296	80,383	93,678	103,896	115,869	125,326	135,792	148,844
BIOLOGY																
	MEAN CHL	7.1	7.2	7.3	7.5	7.6	7.1	7.1	7.3	7.0	7.0	7.0	7.1	7.1	7.3	7.3
	MEDIAN CHL	7.2	7.5	7.6	7.5	7.7	7.4	7.3	7.6	7.0	6.9	7.2	7.2	7.3	7.5	7.5
	N. JOURNALS	53	51	42	62	65	64	65	65	71	72	76	86	85	83	83
	N. ARTICLES	5,493	5,674	4,910	4,914	5,345	5,577	5,539	5,953	6,643	6,741	11,427	15,511	22,001	8,866	8,688
	TOT. CITES	137,526	144,187	129,737	144,368	153,375	164,037	176,385	191,757	217,711	241,521	292,194	346,005	394,117	344,282	352,501
CHEMISTRY, MULTID.																
	MEAN CHL	-	6.6	6.6	6.4	6.3	6.3	6.3	6.1	6.1	6.1	6.0	6.0	5.9	5.8	6.4
	MEDIAN CHL	-	6.8	6.4	6.3	6.3	6.3	6	5.6	5.6	5.7	5.7	5.4	5.4	5.4	6.2
	N. JOURNALS	-	118	118	119	123	125	125	124	128	127	140	147	154	152	231
	N. ARTICLES	-	18,060	19,728	20,796	22,399	24,166	26,519	27,709	29,979	33,322	37,459	42,451	47,283	50,650	62,782
	TOT. CITES	-	517,581	541,052	568,705	622,566	684,778	773,231	874,894	974,232	1,102,967	1,366,617	1,517,807	1,766,863	1,970,524	2,547,761
COMPUTER SCI., INTERD. APPL.																
	MEAN CHL	6.0	6.1	6.1	6.1	6.0	6.0	6.0	6.0	6.1	6.1	6.3	6.2	6.3	6.4	6.3
	MEDIAN CHL	5.7	6	6.1	6.1	6.1	5.7	5.9	5.8	5.9	5.9	6.2	6	5.9	6.1	6.2
	N. JOURNALS	76	75	76	80	83	83	83	87	92	94	95	97	99	100	102
	N. ARTICLES	4,851	5,436	5,373	5,377	5,693	6,427	6,955	7,531	8,710	9,008	9,576	9,926	12,006	11,518	12,374
	TOT. CITES	47,819	53,832	61,119	67,400	75,980	89,486	103,862	121793	138744	149544	172497	182319	197991	225983	251,636
ENGINEERING, MULTID.																
	MEAN	-	7	6.9	7	6.6	6.7	6.9	6.7	6.9	6.7	6.8	6.7	6.6	6.3	6.4
	MEDIAN	-	6.6	7.1	6.9	6.7	6.7	7.1	6.6	6.6	6.5	6.5	6.7	6.4	6.1	6.3
	N. JOURNALS	-	58	58	61	63	61	65	67	67	67	79	87	90	90	87
	N. ARTICLES	-	3,781	3,894	4,048	4,407	4,955	4,891	6,126	6,289	7,162	8,216	7,951	8,647	9,876	11,245
	TOT. CITES	-	30,168	32,972	32,860	43,586	47,670	54,089	63,871	75,430	100,604	113,420	94,312	105,222	116,451	140,356

Table 2b. Dataset, Science Citation Index

SCIENCE CITATION INDEX	YEAR	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
GEOSCIENCES, MULTID.																
	MEAN	7.4	7.4	7.2	7.3	7.3	7.2	7.3	7.2	7.2	7.2	7.4	7.3	7.3	7.4	7.4
	MEDIAN	7.6	7.6	7.1	7.5	7.1	7	7.2	7.1	6.9	7.1	7.6	7.4	7.6	7.8	7.9
	N. JOURNALS	114	117	117	122	128	128	129	131	137	144	155	167	170	172	173
	N. ARTICLES	10,360	10,483	10,859	10,515	12,500	13,210	12,997	13,614	15,150	17,043	17,268	18,026	17,293	20,539	22,385
	TOT. CITES	204,900	215,080	229,390	241,239	294,684	305,637	318,371	348,605	403,346	451,112	535,086	555,465	589,748	665,294	751,740
MATERIALS SCIENCE, MULTID.																
	MEAN	-	6	6	5.9	5.9	5.9	5.9	6.1	6	6.1	6	6	5.9	6.0	6.0
	MEDIAN	-	5.4	5.5	5.4	5.3	5.3	5.4	5.6	5.6	5.8	6	6	5.8	5.9	5.8
	N. JOURNALS	-	168	170	173	177	177	178	176	190	192	214	225	232	241	251
	N. ARTICLES	-	23,165	26,800	27,148	29,557	33,319	35,855	35,703	43,465	45,765	51,853	54,102	61,944	64,622	71,040
	TOT. CITES	-	226,365	253,722	312,534	362,582	420,407	484,920	550,346	658,805	801,101	1,032,900	1,204,523	1,430,148	1,656,558	1,963,285
MATHEMATICS, INTERD. APPL.																
	MEAN	-	-	9.2	8.5	8.0	7.5	7.3	7.3	7.3	7.2	7.5	7.2	7.4	7.5	7.6
	MEDIAN	-	-	10.0	10.0	9.4	8.0	7.2	7.3	7.5	7.3	7.8	7.8	8.0	8.4	8.4
	N. JOURNALS	-	-	20	30	43	52	76	65	74	76	80	93	92	93	95
	N. ARTICLES	-	-	730	1,665	2,492	4,006	6,134	4,848	5,557	6,103	6,737	6,743	7,541	8,434	9,068
	TOT. CITES	-	-	27170	50955	67519	86335	124029	92997	106001	133142	156538	155598	162814	180751	197949
MULTIDISCIPLINARY SCIENCES																
	MEAN	7.6	7.8	7.6	7.9	7.9	7.7	7.5	7.9	7.4	7.2	7.6	7.1	7.3	7	6.8
	MEDIAN	8.5	8.5	8.4	8.1	8.7	8	7.5	8.5	8	7.4	7.8	7.6	8	8.1	7.9
	N. JOURNALS	52	49	45	48	46	45	48	50	50	42	50	59	56	56	55
	N. ARTICLES	10,385	9,383	8,980	9,888	9,437	9,422	10,140	9,826	10,657	10,183	11,054	12,308	10,769	36,788	48,234
	TOT. CITES	942392	950246	977115	1010836	1056725	1119119	1159693	1210477	1288998	1371542	1493123	1579479	1628042	1865672	2079971
PHYSICS, MULTID.																
	MEAN		7.1	7.1	6.9	6.8	6.9	7.0	6.9	7.0	7.0	7.0	7.0	6.9	6.7	6.7
	MEDIAN		7.6	7.8	6.8	6.7	7.1	7.2	7.2	7.1	7.3	7.4	7.3	7.6	7.4	6.8
	N. JOURNALS		69	67	68	68	67	69	68	69	68	71	80	84	83	78
	N. ARTICLES		15,262	15,758	16,492	17,660	19,396	19,273	20,951	20,197	21,885	21,998	21,612	23,087	23,947	23,729
	TOT. CITES		398,442	420,001	455,383	446,208	492,626	529,006	557,507	594,891	651,118	713,531	724,531	731,353	806,550	841,364

Table 3. Dataset, Social Science Citation Index

SOCIAL SCIENCE CIT. INDEX	YEAR	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
EDUCATION & EDUCAT. RES.																
	MEAN	7.5	7.6	7.7	7.8	7.8	7.8	7.8	7.7	7.9	7.9	8.1	7.5	7.4	7.5	7.6
	MEDIAN	7.4	7.8	7.7	7.9	7.8	7.9	8.2	8	8.2	8.4	8.6	7.6	7.5	7.6	7.7
	N. JOURNALS	101	96	92	93	92	91	98	100	105	113	139	184	206	219	219
	N. ARTICLES	3,221	3,146	2,889	3,083	2,991	3,137	3,265	3,477	3,749	4,433	5,339	6,862	8,146	8,909	9,536
	TOT. CITES	26,314	25,455	25,234	30,060	28,835	32,078	33,597	40,013	45,960	62,093	87,498	99,229	109,779	129,726	148,224
INTERNATIONAL RELATIONS																
	MEAN	5.6	5.6	5.8	6.1	6.2	5.9	6.2	6.3	6	6.1	6.9	6.2	6.3	6.6	6.9
	MEDIAN	5.2	5.6	5.4	6	6.2	5.4	5.7	6.3	5.6	5.8	7.1	5.9	6.2	6.6	7.0
	N. JOURNALS	52	52	52	53	52	54	50	50	51	55	59	78	81	83	82
	N. ARTICLES	1,462	1,629	1,615	1,544	1,552	1,665	1,664	1,744	1,772	1,969	2,026	2,639	2,730	2,842	3,064
	TOT. CITES	10,746	12,158	12,780	12,966	13,537	14,588	14,817	16,595	17,442	21,750	33,434	33,733	35,586	40,021	41,780
MANAGEMENT																
	MEAN	7.4	7.3	7.5	7.5	7.4	7.3	7.4	7.6	7.6	7.7	8.2	7.6	7.7	7.5	7.1
	MEDIAN	7.5	7.4	7.6	7.7	7.4	7.3	7.7	7.5	7.6	7.7	8.3	7.8	7.8	7.9	7.4
	N. JOURNALS	63	62	64	68	70	70	74	82	84	92	114	146	168	174	172
	N. ARTICLES	2,474	2,555	2,469	2,555	2,730	2,842	3,101	3,536	3,772	4,091	4,932	5,898	7,064	7,365	7,152
	TOT. CITES	46,461	53,539	54,958	64,479	69,329	75,386	87,417	113,334	130,095	182,477	246,835	279,688	309,457	334,835	356,261
PSYCHOLOGY, MULTID.																
	MEAN	-	-	7.4	7.5	7.5	7.6	7.8	7.9	8	8.1	8	7.8	8	8	8.1
	MEDIAN	-	-	7.7	7.8	7.9	7.7	8.1	7.7	7.8	8.2	8.3	8.3	8.6	8.8	8.7
	N. JOURNALS	-	-	100	102	101	100	101	99	102	101	112	120	125	126	127
	N. ARTICLES	-	-	3,544	3,705	3,905	3,945	3,986	4,234	4,501	4,689	5,199	5,755	6,035	6,142	7,614
	TOT. CITES	-	-	92,583	99,819	104,149	112,246	122,244	136,866	145,693	175,944	205,528	216,785	232,098	253,429	285,621

Table 3. Values of linear best fit, equation $y = ax + b$: grey shade, $R^2 > 0.5$; italics, angular coefficient $a < -0$; bold, angular coefficient $a > 0$.

	Mean			Median		
SCIENCE CITATION INDEX	***a***	***b***	***R²***	***a***	***b***	***R²***
AGRICULTURE, MULTIDISCIPLINARY	*-0.17*	8.70	0.91	*-0.30*	9.99	0.90
BIOLOGY	*-0.01*	7.28	0.08	*-0.01*	7.43	0.04
CHEMISTRY, MULTIDISCIPLINARY	*-0.05*	6.56	0.58	*-0.08*	6.53	0.56
COMPUTERSCIENCE, INTERDISCIPLINARY APPLICATIONS	**0.02**	5.96	0.50	**0.01**	5.86	0.12
ENGINEERING, MULTIDISCIPLINARY	*-0.04*	7.04	0.63	*-0.05*	6.97	0.49
GEOSCIENCES, MULTIDISCIPLINARY	**0.01**	7.25	0.10	**0.02**	7.16	0.12
MATERIALS SCIENCE, MULTIDISCIPLINARY	**0.01**	5.92	0.17	**0.05**	5.23	0.73
MATHEMATICS, INTERDISCIPLINARY APPLICATIONS	*-0.10*	8.36	0.43	*-0.13*	9.10	0.24
MULTIDISCIPLINARY SCIENCES	*-0.06*	7.98	0.62	*-0.05*	8.47	0.32
PHYSICS, MULTIDISCIPLINARY	*-0.02*	7.05	0.27	*-0.01*	7.26	0.01
SOCIAL SCIENCE CITATION INDEX						
EDUCATION & EDUCATIONAL RESEARCH	**0.00(2)**	7.73	0.00	**0.01**	7.81	0.01
INTERNATIONAL RELATIONS	**0.07**	5.59	0.67	**0.09**	5.27	0.52
MANAGEMENT	**0.01**	7.40	0.07	**0.02**	7.43	0.19
PSYCHOLOGY, MULTIDISCIPLINARY	**0.06**	7.44	0.81	**0.09**	7.45	0.83

Table 3a. Values of linear best fit, significant values only ($R^2 > 0.5$); italics, angular coefficient < -0; bold, angular coefficient > 0.

	Mean			Median		
SCIENCE CITATION INDEX	***a***	***b***	***R²***	***a***	***b***	***R²***
AGRICULTURE, MULTIDISCIPLINARY	*-0.17*	8.70	0.91	*-0.30*	9.99	0.90
CHEMISTRY, MULTIDISCIPLINARY	*-0.05*	6.56	0.58	*-0.08*	6.53	0.56
ENGINEERING, MULTIDISCIPLINARY	*-0.04*	7.04	0.63			
MATERIALS SCIENCE, MULTIDISCIPLINARY				**0.05**	5.23	0.73
MULTIDISCIPLINARY SCIENCES	*-0.06*	7.98	0.62			
SOCIAL SCIENCE CITATION INDEX						
INTERNATIONAL RELATIONS	**0.07**	5.59	0.67	**0.09**	5.27	0.52
PSYCHOLOGY, MULTIDISCIPLINARY	**0.06**	7.44	0.81	**0.09**	7.45	0.83

Table 4. Values of Spearman's ρ: grey shade, P < 0.05; italics, ρ < -0; bold, ρ > 0.

		MEAN		MEDIAN	
	Deg. of freedom	**Rho**	**P-value**	**Rho**	**P-value**
SCIENCE CITATION INDEX					
AGRICULTURE, MULTIDISCIPLINARY	12	*-0.9560*	0.0000	*-0.9560*	0.0000
BIOLOGY	13	*-0.2163*	0.4388	*-0.2042*	0.4655
CHEMISTRY, MULTIDISCIPLINARY	12	*-0.7319*	0.0029	*-0.7823*	0.0009
COMPUTER SCIENCE, INTERDISCIPLINARY APPLICATIONS	13	**0.6286**	0.0121	**0.3062**	0.2670
ENGINEERING, MULTIDISCIPLINARY	12	*-0.7802*	0.0010	*-0.6998*	0.0053
GEOSCIENCES, MULTIDISCIPLINARY	13	**0.3000**	0.2773	**0.3382**	0.2176
MATERIALS SCIENCE, MULTIDISCIPLINARY	12	**0.4967**	0.0708	**0.8244**	0.0003
MATHEMATICS, INTERDISCIPLINARY APPLICATIONS	11	*-0.0273*	0.9295	**0.2283**	0.4531
MULTIDISCIPLINARY SCIENCES	13	*-0.7554*	0.0011	*-0.5869*	0.0215
PHYSICS, MULTIDISCIPLINARY	12	*-0.2747*	0.3418	**0.1919**	0.5111
SOCIAL SCIENCE CITATION INDEX					
EDUCATION & EDUCATIONAL RESEARCH	13	*-0.0429*	0.8795	*-0.0125*	0.9646
INTERNATIONAL RELATIONS	13	**0.8214**	0.0002	**0.7126**	0.0029
MANAGEMENT	13	**0.4286**	0.1110	**0.4466**	0.0951
PSYCHOLOGY, MULTIDISCIPLINARY	11	**0.7727**	0.0020	**0.8617**	0.0002

Table 4a. Values of Spearman's ρ, significant values only (P < 0.05); italics, ρ < -0; bold, ρ > 0.

		MEAN		MEDIAN	
	Deg. of freedom	**Rho**	**P-value**	**Rho**	**P-value**
SCIENCE CITATION INDEX					
AGRICULTURE, MULTIDISCIPLINARY	12	*-0.9560*	0.0000	*-0.9560*	0.0000
CHEMISTRY, MULTIDISCIPLINARY	12	*-0.7319*	0.0029	*-0.7823*	0.0009
COMPUTER SCIENCE, INTERDISCIPLINARY APPLICATIONS	13	**0.6286**	0.0121		
ENGINEERING, MULTIDISCIPLINARY	12	*-0.7802*	0.0010	*-0.6998*	0.0053
MATERIALS SCIENCE, MULTIDISCIPLINARY	12			**0.8244**	0.0003
MULTIDISCIPLINARY SCIENCES	13	*-0.7554*	0.0011	*-0.5869*	0.0215
SOCIAL SCIENCE CITATION INDEX					
INTERNATIONAL RELATIONS	13	**0.8214**	0.0002	**0.7126**	0.0029
PSYCHOLOGY, MULTIDISCIPLINARY	11	**0.7727**	0.0020	**0.8617**	0.0002

Table 5. Values of linear best fit, mean and median vs. n° of article in the Subject category per year, equation $y = ax + b$: grey shade, $R^2 > 0.5$; italics, angular coefficient < -0; bold, angular coefficient > 0.

	Equation, mean; R^2, mean			Equation, median; R^2, median		
SCIENCE CITATION INDEX	***a***	***b***	R^2	***a***	***b***	R^2
AGRICULTURE, MULTIDISCIPLINARY	*-1,776.64*	17,410.81	0.94	*-966.67*	11,739.93	0.85
BIOLOGY	*-9,678.63*	77,826.09	0.14	*-4,630.90*	42,255.94	0.05
CHEMISTRY, MULTIDISCIPLINARY	*-29,937.47*	219,096.52	0.33	*-16,174.85*	128,929.03	0.30
COMPUTER SCIENCE, INTERDISCIPLINARY APPLICATIONS	**14,259.11**	-79,371.99	0.57	**5,273.73**	-23,415.88	0.11
ENGINEERING, MULTIDISCIPLINARY	*-9,016.50*	67,287.95	0.65	*-6,480.57*	49,422.33	0.59
GEOSCIENCES, MULTIDISCIPLINARY	**18,368.47**	-119,169.83	0.16	**5,277.68**	-24,045.22	0.19
MATERIALS SCIENCE, MULTIDISCIPLINARY	**86,055.12**	-470,407.78	0.12	**51,638.06**	-246,743.81	0.71
MATHEMATICS, INTERDISCIPLINARY APPLICATIONS	*-3,340.39*	30,964.02	0.60	*-1,670.68*	19,120.74	0.42
MULTIDISCIPLINARY SCIENCES	*-24,476.00*	197,740.60	0.53	*-3,667.93*	44,084.90	0.02
PHYSICS, MULTIDISCIPLINARY	*-11,440.04*	99,368.91	0.28	*-639.08*	24,699.56	0.01
SOCIAL SCIENCE CITATION INDEX						
EDUCATION & EDUCATIONAL RESEARCH	*-5,428.76*	46,682.66	0.19	*-1,928.27*	20,000.54	0.08
INTERNATIONAL RELATIONS	**916.25**	-3,668.17	0.46	**603.45**	-1,624.20	0.40
MANAGEMENT	**1,228.16**	-5,061.49	0.03	**3,342.32**	-21,299.38	0.19
PSYCHOLOGY, MULTIDISCIPLINARY	**3,814.21**	-24,984.43	0.57	**2,778.82**	-17,632.05	0.83

Table 5a. Values of linear best fit, mean and median vs. n° of article in the Subject category per year, equation $y = ax + b$, significant values only ($R^2 > 0.5$)

	Equation, mean; R^2, mean			Equation, median; R^2, median		
SCIENCE CITATION INDEX	***a***	***b***	R^2	***a***	***b***	R^2
AGRICULTURE, MULTIDISCIPLINARY	*-1,776.64*	17,410.81	0.94	*-966.67*	11,739.93	0.85
COMPUTER SCIENCE, INTERDISCIPLINARY APPLICATIONS	**14,259.11**	-79,371.99	0.57			
ENGINEERING, MULTIDISCIPLINARY	*-9,016.50*	67,287.95	0.65	*-6,480.57*	49,422.33	0.59
MATERIALS SCIENCE, MULTIDISCIPLINARY				**51,638.06**	-246,743.81	0.71
MATHEMATICS, INTERDISCIPLINARY APPLICATIONS	*-3,340.39*	30,964.02	0.60			
MULTIDISCIPLINARY SCIENCES	*-24,476.00*	197,740.60	0.53			
SOCIAL SCIENCE CITATION INDEX						
PSYCHOLOGY, MULTIDISCIPLINARY	**3,814.21**	-24,984.43	0.57	**2,778.82**	-17,632.05	0.83