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Institutional self-citation rates: A three year study of universities in the United States

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Using Institute for Scientific Information (ISI) data, this paper calculated institutional self citations rates (ISCRs) for 96 of the top research universities in the United States from 2005-2007. Exhibiting similar temporal patterns of author and journal self-citations, the ISCR was 29% in the first year post-publication, and decreased significantly in the second year post-publication (19%). Modeling the data via power laws revealed total publications and citations did not correlate with the ISCR, but did correlate highly with ISCs. California Institute of Technology exhibited the highest ISCR at 31%. Academic and cultural factors are discussed in relation to ISCRs.

Introduction

Bibliometric statistics are used by institutions of higher education to evaluate the research quality and productivity of their faculty. With careers, funding, and individual, journal and institutional reputations at stake, the establishment of fair bibliometric indicators and standards has become vital. In light of this atmosphere, self-citations in all their forms, has created controversy among scholars. At the author level, categories of self-citations [BALDI, 1998; WHITE, 2001] and their statistical characteristics [FALAGAS & KAVVADIA, 2006] have been examined in the scientific literature. Several researchers studied the influence of author self-citations – specifically, ramifications on the professional reputations of scholars [FOWLER & AKSNES, 2007; HYLAND, 2003; LAWANI, 1982]; bibliometric measures such as journal impact factors [SEGLEN, 1997], Hirsch's *h*-index [KELLY & JENNIONS, 2006; SCHREIBER, 2007A; 2007C] and Egghe's *g*-index [SCHREIBER, 2007B]; field mobility metrics [AUSLOOS & AL., 2007; HELLSTEN & AL., 2007]; and scholarly communication trends [GLÄNZEL & AL., 2006]. Interpretations of the exact effect on scholarship and bibliometrics differed among researchers. Some scholars construed author self-citations as potentially detrimental to accurate bibliometric analysis [GAMI & AL., 2004; MACROBERTS & MACROBERTS, 1989; PERSSON & BECKMANN, 1995; VAN RAAN, 1998]. Pointedly, Schreiber wrote that self-citations significantly alter authors' *h*-indices [KELLY & JENNIONS, 2006;

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SCHREIBER, 2007A; 2007C] and *g*-indices [SCHREIBER, 2007B], thus manipulation of bibliometric indicators is a legitimate concern. Conversely, Engqvist and Frommen stated the removal of frivolous self-citations or even all author self-citations has a trivial effect on *h*-indices [ENGQVIST & FROMMEN, 2008]. Other research demonstrated the important role self-citations play in identifying researchers' field mobility patterns (HELLSTEN & AL., 2007) and establishing academic reputations [HYLAND, 2003]. Suggesting that the influence of self-citations was related to the scope of a study, two research papers argued that self-citations skew bibliometric indicators of individuals and small groups of researchers, but have negligible impact at the macro level. [AKSNES, 2003; THIJS & GLÄNZEL, 2005].

The influence of journal-level bibliometric measures, such as the Institute for Scientific Information's (ISI) impact factor, inspired research on journal self-citations and their disciplinary impacts. Focusing on the inherent characteristics of journal self-citations, Rousseau described journal self-citation rates over a ten year period [ROUSSEAU, 1999]. Correlating journal impact factor and self-citation rates, Frandsen noted that a higher proportion of journal self-citations related to lower journal impact factors [FRANDSEN, 2007]. Tsay noted that journal self-citations may be associated with the age and publication frequency of a journal [TSAY, 2006]. This may occur due to the reliance on journal self-citations by journals in their nascent phases. As with individual self-citations, opinions regarding the impact of journal self-citations vary among scholars. Nisonger compared ISI journal impact factors and the ranks of journals with and without journal self-citations, and found that journal self-citations did not affect the rankings of the vast majority of journals studied. Thus, he concluded that the utility of journal impact factors as a collection development tool was not compromised by journal self-citations [NISONGER, 2000]. Due to correlative relationships between journal self-citations and journal impact factor, the potential manipulation of journal impact factors by journal self-citations has been noted by several scholars [ANSEEL & AL., 2004; DEMARIA, 2003; FASSOULAKI & AL., 2000; MOTAMED & AL., 2002].

Though studies concerning departmental or research group bibliometric characteristics were abundant, the author uncovered only one research study that significantly addressed self-citations in an institutional context. In studying the largest European universities, van Raan found significant negative correlations between universities' author self-citation rate and research performance, and an insignificant negative correlation between total number publications and the universities' author self-citation rate [VAN RAAN, 2008A]. The author did not retrieve any studies specific to institutional self-citations (ISC) or institutional self-citation rates (ISCR).

An ISC is a citation that references works written by researchers employed at the citing author's institution, including his or her own research. Mathematically, the ISCR is defined the total number of ISCs divided by the total number of citations received by an institution's researchers times 100 (*ISCR = (ISC / total citations received)×100*).

According to Lawani's definition, the ISCR is the institution's diachronous self-citedness rate [LAWANI, 1982]. Employing raw citation data gathered and synthesized from ISI's online citation index, Web of Science, this study intends to analyze the phenomenon of ISCs and ISCRs at top research universities in the United States from 2005–2007.

Methodology

Using the basic classification criteria from the Carnegie Commission on Higher Education Carnegie Classification, the study limited to doctorate-granting universities classified as research universities with "very high research activity" (n=96). In searching for research from specific universities, the author used broad searches in the Web of Science address field and limited to three years: 2005, 2006 and 2007. This data was searched during the week of December 2, 2007 through December 8, 2007 to avoid data inconsistencies due to database updates. The results of the search were subsequently refined by institution using the "Analyze Results" feature in Web of Science. The author exercised due diligence in capturing all possible name variants of a university (i.e., Univ N Carolina, UNC, Univ North Carolina) within Web of Science. For each university search, a citation report was run within Web of Science on the refined results set to gather and synthesize the following measures:

- the total number of published articles (*a*)
- the total number of citations to published articles (*c*)
- the total number of institutional self-citations (*s, or ISC*)
- the average number of citations per article (*c/a*)
- the average number of self-citation citations per articles (*s/a*)
- the institutional self-citation rate (*s/c, or ISCR*)

Due to the large number of articles published, the author could not run one citation report for Harvard University and the University of Texas at Austin. Articles and the accompanying citation data from these two institutions were harvested through several smaller searches, de-duplicated, totaled, and subsequently analyzed. Modeling the data via power laws, correlations between bibliometric measures were calculated.

Results

Data analysis

Overall, 19% of the collected citations were ISCs, and for the individual years studied, 2007, 2006 and 2005, the ISCRs were 28%, 19% and 18%, respectively. Figure 1 and Figure 2 illustrate the temporal characteristics for ISCs and ISCRs for selected universities based on their ISCR percentiles.

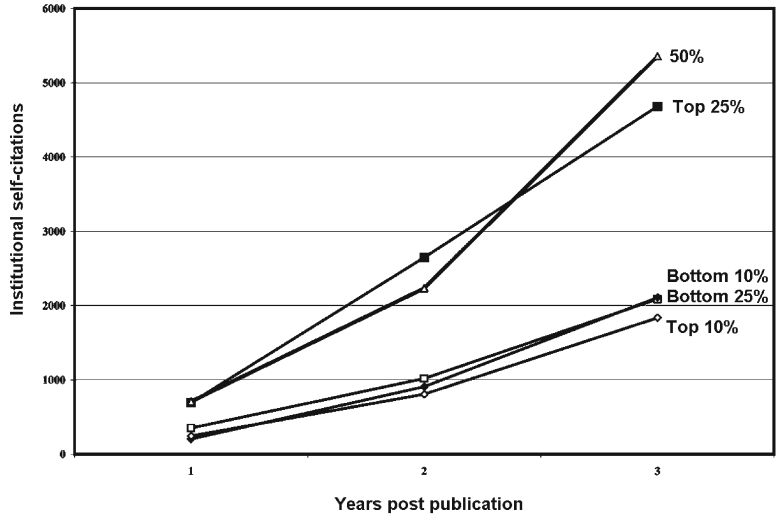

Figure 1. Institutional self-citations over time

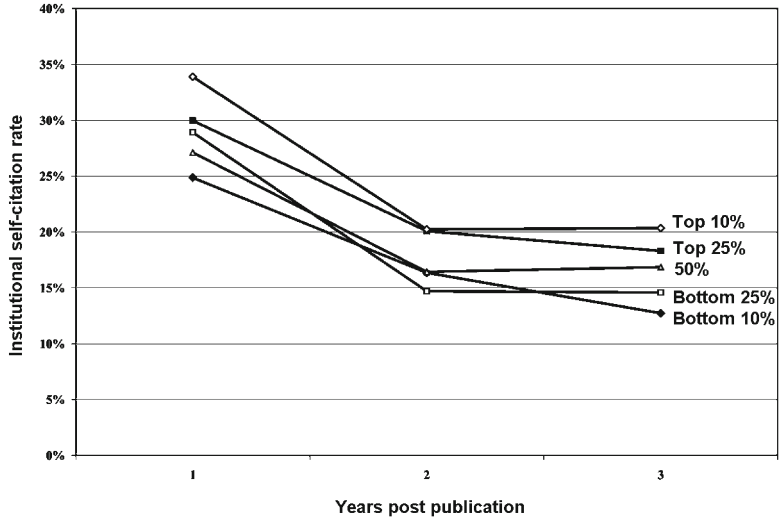

Figure 2. Institutional self-citation rates over time

Among the studied universities, the University of California-Riverside represented the ninetieth percentile (high ISCR); Ohio State University represented the seventy-fifth percentile; Washington University in St. Louis represented the median of the sample;

the University of Illinois at Chicago represented the twenty-fifth percentile; and the University of Connecticut represented the tenth percentile (low ISCR).

For the aggregate, the ISCR was higher within the first year (mean=28%, n=96) than those published between one to three years ago (mean=18%, n=96). Moreover, universities demonstrated a higher ISCR within the first two years (mean=20%, n=96) than the rate of articles older than 2 years (mean=18%, n=96). Only one university, Brandeis University had a higher ISCR in year two than in year one, and twenty-six (27%, n=96) had a higher ISCR in year three than in year two. Due to the study's static population of papers, extramural citations diminished the ICSR over time.

The Appendix provides article, citation and ISCR data for the 96 universities studied, ranked by ISCR. The California Institute of Technology exhibited the highest ISCR of the studied schools by a wide margin. Table 1 shows the results of the power law analysis between the ISCR and other variables. Only two variables, total number of ISCs and average ISCs per article, showed significant correlative relationships with the ISCR. Raw totals of articles and citations did not correlate with an institution's ISCR, but correlated highly with the size-dependent measure, total number of ISCs (R^2= 0.8622 for articles; R^2= 0.9548 for citations).

The size-independent measures, average citation per article, ISCR, and average self-citations per article demonstrated the least amount of variance. However, size dependent measures demonstrated much more variance due to significant outliers in the population. Five universities exceeded three standard deviations from the mean, four positively (California Institute of Technology, Harvard University, Massachusetts Institute of Technology, and the University of Texas at Austin) and one negatively (University of Colorado at Denver and Health Sciences Center), in at least one of the studied indicators. The author did not remove the universities from the sample, but performed an alternate analysis of the data without the outliers (n=91). Without the outliers, the author calculated lower R^2 values and lower power law exponents for all studied variables and the ISCR. The results of the alternate analysis are presented in Table 1.

Table 1. Power law correlations of bibliometric variables with the ISCR

	All institutions (n=96)		Institution population without outliers (n=91)	
Variable	R^2	Equation	R^2	Equation
Articles	0.1697	$ISCR = 0.0518x^{0.1313}$	0.0543	$ISCR = 0.0983x^{0.0609}$
Citations	0.2110	$ISCR = 0.0474x^{0.1267}$	0.0664	$ISCR = 0.0936x^{0.0596}$
ISC	0.4066	$ISCR = 0.0478x^{0.1526}$	0.2039	$ISCR = 0.0766x^{0.0965}$
Citations per Article	0.1141	$ISCR = 0.1245x^{0.3065}$	0.0293	$ISCR = 0.1494x^{0.1319}$
ISC per Article	0.6363	$ISCR = 0.2401x^{0.4637}$	0.4773	$ISCR = 0.2294x^{0.3905}$

Methodological limitations

Due to the nature of Web of Science's data set and capabilities, limitations to this methodology existed. Omitting citation histories of thousands of journals, proceedings, technical reports and patents, Web of Science is not an exhaustive resource. Clearly, the longevity of ISC behaviors cannot be measured by the author due to the time frame studied. Broad in scope, this study did not account for unique disciplinary citation behaviors, so this data can not be extrapolated to represent ISCR of specific departments or research groups. The author conceded publications linked to institution names that were misspelled or used unfamiliar variants in the address field were not retrieved. Furthermore, Moed estimated that 7% of citations from ISI databases contain errors (H. F. MOED, 2002). No proportional attribution techniques were applied in the case of multiple authors from different institutions. Finally, the studied three year window does not adequately reveal the temporal nature of the ISCR, but may only describe immediate characteristics.

Comparison to other studies

The author did not discover studies explicitly addressing ISCRs, but did find similar research regarding author self-citations. In comparing this study's power law models with van Raan's analysis of European universities, the data showed that the number of publications positively influences the total number of self-citations at the largest United States universities at a greater rate than at the largest European universities. Van Raan also found that research performance negatively correlated with self-citation rates. Though research performance was not calculated in this study, some of the United States' most prestigious institutions – California Institute of Technology, Harvard University, Princeton University, and Massachusetts Institute of Technology – exhibited some of the highest ISCRs. Both studies found the relationship between the total number of publications and self-citation rates insignificant, however, this study found a generally positive relationship (Table 1) and van Raan found the relationship to be negative (A. F. J. VAN RAAN, 2008a). This study also corroborates another van Raan study that concluded more publications produced at an institution increases ISCs at a higher rate than external citations based on power law exponents (A. F. J. VAN RAAN, 2008b). The author calculated a power law exponent of 1.24 for ISCs, and 1.09 for external citations.

If all fields are indexed correctly, the ISCR should be higher than the author self-citation rate. In other self-citation studies, author self-citation rates are listed at various percentages – some much higher than this study's overall ISCR (D. W. AKSNES, 2003; P. O. SEGLEN, 1997); some much lower (K. HYLAND, 2003); and some very similar to the overall ISCR (M. E. FALAGAS & P. KAVVADIA, 2006; A. S. GAMI et al., 2004).

Despite the limited three year window, the ISCR exhibits similar temporal patterns of author and journal self-citation rates. Namely, the highest rate of self-citation occurs within the first year of an article being published [ADAMS & AL, 2004; AKSNES, 2006; MACZELKA & ZSINDELY, 1992].

Discussion

The ISCR may lend insights into the recent academic culture of an institution, and may shed some light on the motivations of authors who cite authors from their own institutions. High ISCRs may indicate the presence of genuine "invisible colleges" within an institution, or negatively, intentional "citation circles" where researchers deliberately cite certain researchers for the express purpose of inflating bibliometric indicators (E. GARFIELD & A. WELLJAMS-DOROF, 1992). An institution's tenure and promotion rubric that overemphasizes citation indices may unintentionally incentivize individual self-citation, or the creation of "citation circles", thus exaggerating the ICSR. On the other hand, universities or departments within universities with excellent reputations may generate more legitimate self-citations. A highly focused or unique research orientation of an institution may manifest itself in the form of higher ISCRs. For instance, California Institute of Technology demonstrated a much higher ISCR, most probably due to the state-of-the-art research being done at specialized laboratories, such as the Jet Propulsion Laboratory. Furthermore, if specialized research groups or departments exist within a university in highly cited fields such as astronomy and astrophysics, the ISCR may rise. The social environment and intra-faculty familiarity may play a role, though institution size does not seem to make a difference in ISCRs. Universities with faculties that typically collaborate more, write longer articles and cite more extensively may influence the ISCR positively. It is doubtful that an insular academic culture may be to blame for a higher ICSR, due to the ease and frequency of extramural collaboration in the digital age. A university with a higher percentage of articles published in highly cited journals may also experience a high ISCR as these articles are more likely to be cited generally. Unique and emerging research topics may spawn specialty journals, which in their nascency may have a tendency to self-cite (H. MACZELKA & S. ZSINDELY, 1992), consequently raising the ISCR for institutions that employ researchers in these areas.

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Appendix
Article, citation and ISCR data for selected United States universities, ranked by ISCR

Research universities	Total articles	Total citations	Total ISC	Average citations per article	Average ISC per article	ISCR
California Institute of Technology	8862	47958	14787	5.41	1.67	30.83%
Harvard University	43458	228110	56950	5.25	1.31	24.97%
Pennsylvania State University	14991	42245	10316	2.82	0.69	24.42%
Princeton University	8227	31529	7563	3.83	0.92	23.99%
University of Arizona	11884	36710	8718	3.09	0.73	23.75%
Carnegie Mellon University	4672	13475	3153	2.88	0.67	23.40%
Iowa State University	6935	16913	3834	2.44	0.55	22.67%
University of California-Santa Cruz	3259	16049	3623	4.92	1.11	22.57%
Massachusetts Institute of Technology	10457	66625	14731	6.37	1.41	22.11%
University of California-Riverside	4888	13733	2887	2.81	0.59	21.02%
University of Hawaii at Manoa	5659	16959	3565	3.00	0.63	21.02%
Rice University	3365	10933	2287	3.25	0.68	20.92%
University of California-Santa Barbara	6761	25560	5313	3.78	0.79	20.79%
Johns Hopkins University	24877	95442	19745	3.84	0.79	20.69%
SUNY at Albany	2832	6803	1395	2.40	0.49	20.51%
University of Notre Dame	3997	11072	2263	2.77	0.57	20.44%
Texas A & M University	12380	26072	5317	2.11	0.43	20.39%
University of California-Berkeley	18150	70642	14377	3.89	0.79	20.35%
Michigan State University	9579	21848	4444	2.28	0.46	20.34%
Purdue University	10393	22479	4566	2.16	0.44	20.31%
University of Texas at Austin	45878	148254	29863	3.23	0.65	20.14%
University of Illinois at Urbana-Champaign	12003	30805	6098	2.57	0.51	19.80%
University of California-Los Angeles	25629	84387	16673	3.29	0.65	19.76%
Ohio State University	15730	41115	8025	2.61	0.51	19.52%
University of Washington-Seattle Campus	23283	87860	16762	3.77	0.72	19.08%
Colorado State University	5411	13084	2495	2.42	0.46	19.07%
University of Michigan-Ann Arbor	25042	76859	14536	3.07	0.58	18.91%
University of Wisconsin-Madison	21598	58082	10900	2.69	0.50	18.77%
Rensselaer Polytechnic Institute	2624	6488	1211	2.47	0.46	18.67%
Oregon State University	4905	10385	1908	2.12	0.39	18.37%
University of Pennsylvania	21870	75421	13832	3.45	0.63	18.34%
University of Cincinnati	8512	23944	4391	2.81	0.52	18.34%
University of California-San Diego	17674	67604	12329	3.83	0.70	18.24%
University of Chicago	12199	43129	7837	3.54	0.64	18.17%
Yale University	17120	62601	11275	3.66	0.66	18.01%
University of Pittsburgh	18764	55824	10043	2.98	0.54	17.99%
Arizona State University	6923	14442	2591	2.09	0.37	17.94%
Duke University	17596	60241	10781	3.42	0.61	17.90%
Georgia Institute of Technology	7497	17733	3161	2.37	0.42	17.83%
University of Tennessee	9198	22236	3951	2.42	0.43	17.77%
University of Kentucky	7630	17160	3043	2.25	0.40	17.73%
Vanderbilt University	11137	36799	6524	3.30	0.59	17.73%
University of Florida	17219	37173	6551	2.16	0.38	17.62%
University of California-Irvine	9907	32283	5679	3.26	0.57	17.59%
Stanford University	21320	79824	13998	3.74	0.66	17.54%
University of Minnesota	19273	52424	9142	2.72	0.47	17.44%
University of Maryland	17419	46137	8033	2.65	0.46	17.41%
Virginia Polytechnic Institute and State University	5920	10083	1747	1.70	0.30	17.33%
Washington University in St. Louis	13516	48026	8299	3.55	0.61	17.28%
Cornell University	17410	55566	9588	3.19	0.55	17.26%
Wayne State University	7507	18417	3154	2.45	0.42	17.13%
Northwestern University	14308	44627	7555	3.12	0.53	16.93%
Kansas State University	3267	5823	984	1.78	0.30	16.90%

Appendix (cont.)

Research universities	Total articles	Total citations	Total ISC	Average citations per article	Average ISC per article	ISCR
University of Colorado at Boulder	15126	50844	8559	3.36	0.57	16.83%
Columbia University in the City of New York	20259	69247	11655	3.42	0.58	16.83%
SUNY at Stony Brook	6331	19164	3216	3.03	0.51	16.78%
University of Massachusetts	10888	32691	5460	3.00	0.50	16.70%
University of California-Davis	16106	41585	6878	2.58	0.43	16.54%
Montana State University	1849	4021	663	2.17	0.36	16.49%
University of Iowa	10073	26797	4401	2.66	0.44	16.42%
Florida State University	4908	10936	1783	2.23	0.36	16.30%
Rutgers University	8880	21289	3447	2.40	0.39	16.19%
Indiana University	13506	31254	5059	2.31	0.37	16.19%
North Carolina State University at Raleigh	7072	13838	2226	1.96	0.31	16.09%
University of North Carolina	18458	53281	8546	2.89	0.46	16.04%
University of Georgia	7351	15565	2493	2.12	0.34	16.02%
Brandeis University	1580	5651	900	3.58	0.57	15.93%
University of Virginia	9636	27939	4430	2.90	0.46	15.86%
University of Nebraska	7648	14192	2242	1.86	0.29	15.80%
University of Delaware	4482	9071	1431	2.02	0.32	15.78%
Washington State University	4602	9561	1497	2.08	0.33	15.66%
University of New Mexico	5642	14600	2248	2.59	0.40	15.40%
University of Illinois at Chicago	9505	22483	3458	2.37	0.36	15.38%
University of Rochester	8129	26621	4055	3.27	0.50	15.23%
Tufts University	7069	24318	3659	3.44	0.52	15.05%
University of South Carolina	7558	21125	3155	2.80	0.42	14.93%
University of Alabama at Birmingham	9543	26937	4012	2.82	0.42	14.89%
Brown University	7130	20317	3017	2.85	0.42	14.85%
Louisiana State University	8623	18242	2688	2.12	0.31	14.74%
University of Kansas	6002	12834	1879	2.14	0.31	14.64%
New York University	12155	35957	5245	2.96	0.43	14.59%
Emory University	11998	35077	5105	2.92	0.43	14.55%
University of Utah	9643	26990	3926	2.80	0.41	14.55%
SUNY at Buffalo	5692	13331	1937	2.34	0.34	14.53%
Boston University	10731	34184	4859	3.19	0.45	14.21%
University of Miami	7060	18568	2636	2.63	0.37	14.20%
Tulane University	3844	9824	1387	2.56	0.36	14.12%
University of Connecticut	8903	22983	3222	2.58	0.36	14.02%
University of Southern California	11170	29844	4151	2.67	0.37	13.91%
University of Missouri	10297	18415	2408	1.79	0.23	13.08%
University of South Florida	5542	11902	1543	2.15	0.28	12.96%
Case Western Reserve University	8416	26064	3375	3.10	0.40	12.95%
Dartmouth College	4975	15823	2040	3.18	0.41	12.89%
Georgetown University	5238	12081	1400	2.31	0.27	11.59%
Yeshiva University	1156	4932	451	4.27	0.39	9.14%
University of Colorado at Denver and Health Sciences Center	856	1807	83	2.11	0.10	4.59%