Jointly published by Akadémiai Kiadó, Budapest and Springer, Dordrecht

Scientometrics, Vol. 81, No. 1 (2009) 7–31
DOI: 10.1007/s11192-009-1870-4

Countries positioning in Open Access Journals system: An investigation of citation distribution patterns

HAJAR SOTUDEH,[a] ABBAS HORRI[b]

[a] *Department of Library and Information Science, Shiraz University, Shiraz (Iran)*
[b] *Department of Library and Information Science, University of Tehran, Tehran (Iran)*

By their widespread availability and dissemination through open access media, scholarly outputs witness an improved visibility supposed to cause a better citation performance. However, due to the existence of the Matthew effect in science system, which affects users' perceptions of quality, ultimate effects of the enhanced visibility on different entities are obscure. Moreover, different attitudes towards open access give rise to a more strong quality dynamics in the open access world. Aiming to explore the consequence of the interaction between visibility and quality dynamics, this study investigates countries positioning in open access journals. The results show that the world's countries welcome open access pattern whether by submitting to or publishing open access journals. A large proportion of the enduring, prestigious open access journals are published by scientifically proficient and developing nations, emphasizing their successful commitment to maintain the undertaken role. The results of the citation analysis highlight national inequalities regarding citation distributions among countries contributing to the journals within the system and within individual disciplines in the system. Well-performing countries mainly consist of advanced ones; however, some less-developed nations are found to perform well in the journal system.

Introduction

Due to the fact that Open Access (OA) leads to a great improvement in access, availability, and distribution, OA scientific publications are expected to gain a higher visibility, and usability or influence characterized partially by their higher citation rates (see e.g. [ANTELMAN, 2004; BRODY & AL., 2004; HARNAD & BRODY, 2004; KURTZ & AL., 2004A; 2004B; 2005; HAJJEM & AL., 2005A; 2005B; EYSENBACH, 2006A; 2006B]). In other words, much of their potential research impact is to be achieved, which otherwise would be lost due to their inaccessibility [HITCHCOCK & AL., 2003; HARNAD & BRODY, 2004; HARNAD & AL., 2004]. The controversial point is that biases ruling over referencing behaviors (see e.g. [MACROBERTS & MACROBERTS, 1989; 1996; BORGMAN & FURNER, 2002]) add a complicated feature to the study of citation advantage of OA materials. For example, the existence of some phenomena, like Matthew effect or Halo effect [MERTON, 1968; 1988; COLE, 1992; 2000] in science, cause inequalities in different entities' credit even for occasionally comparable contributions, resulting in the skewness of reward distribution. Consequently, from a

Received October 10, 2007; Published online March 18, 2009

Address for correspondence:
HAJAR SOTUDEH
E-mail: hsotudeh@shirazu.ac.ir

0138–9130/US $ 20.00

scientometric point of view a few entities, expecting high numbers of citations, acquire even more citations; while many others expecting lower numbers of citations gain even less. The phenomenon is proved to be in force at different aggregation levels (e.g. [BONITZ, 1997; BONITZ, 2002; BONITZ & AL., 1997; 1999; BONITZ & SCHARNHORST, 2001; KATZ, 1999A; 1999B; 2000]).

In addition to the effects of dynamics of science, further complexities are brought about by OA dynamics: scientists' attitudes towards OA are found to differ geographically [NICHOLAS, 2005] and from one discipline to another, depending largely on the norms and practices prevailing in their specialties. They widely embrace OA in some disciplines such as biological chemistry, physics and astronomy (see e.g. [HILGARTNER, 1995; YOUNGEN, 1998; MCCAIN, 2000; BROWN, 2001A; 2001B]), and are relatively reluctant in some other disciplines like chemistry [WARR, 2003; BROWN, 2003]. Under these conditions, OA appears to confront some conflicting forces that may interact as diametrically opposed, unbalanced vectors. On the one hand, the OA publishing is potentially promising in improving the citation performance; on the other, the effect may be counteracted by science sociological phenomena for some entities. It is not clear, therefore, how quality dynamics and visibility dynamics contribute to the citation counts of OA papers and what the result of this interaction would be. It is consequently necessary to study how entities vary in their positioning in OA club, in other words, how equitably citations are distributed between them.

The importance of this matter relies generally on the fact that citation improvement is considered as one of the indicators of a better positioning of scientific contributions, and may result in improvement in funding, prestige, and impetus to the careers of researchers [HARNAD, 2003]. Thus, in order to endorse OA, everyone involved in science namely scholars, publishers, research managers, and policymakers would like to and should know: what may be the return if they invest on OA journals (OAJ) or repositories? Does it result in improving awareness and sharing of their contribution to knowledge progress? If so, does the extent of the improvement worth investing on OA publishing? This is of especial importance to less-developed countries, where the information and communication infrastructure, required to establish OA systems, does not exist or is very poor, and research funds are scarce. Consequently, before rushing to implement OA projects, it is required to ensure their usefulness in order to avoid double loss of investing the scarce research funds and endangering their journal subscription revenues without bringing on any tangible outcomes.

This study aims to explore the positioning of the world's countries in OA journals as a result of the interaction between visibility and quality dynamics, and reports on the outcomes of a citation analysis carried at a country aggregation level. The study reflects how OA citations are distributed between contributing countries, and how effectively they contribute to the OAJ system, and also in individual scientific disciplines during the period examined, 2001–2003.

Related studies

The evaluation of countries' citation performance at the global level has been on the focus of many studies. The long series published by Braun and his colleagues are an important exemplary in this regard. Exploring the world's countries scientific contributions, they report on the expected and observed levels of the countries' citation performance for the periods 1978–1980, 1981–1985 and 1980–1989 (see e.g. [BRAUN & AL., 1985; 1987; 1988A; 1988B; 1988C; 1989; 1993; 1994A;1994B; SCHUBERT & AL., 1989]). Some of the global studies are specifically directed towards the investigation of inequalities in citation distribution in the science system using different methods and at different levels of aggregation. Robert K. Merton is one of the pioneers, who in 1968 explored the inequalities affecting recognition and award allocation systems in science [MERTON, 1968]. Based on Harriet Zuckerman's hours-long interviews with Nobel laureates in the early 1960s, he set forth in his classical outstanding piece that award allocation institutions are not able to reward people with the same share of contributions – due to their limitations or misjudgment partially rooted in subjectivism. Consequently, "eminent scientists get disproportionately great credit for their contributions to science, while relatively unknown ones tend to get disproportionately little for their occasionally comparable contributions" [MERTON, 1988, P. 608].

The phenomenon is interpreted as 'the rich get richer and the poor get poorer'. However, when Bonitz and his colleagues carried out a series of ingeniously designed investigations to verify the phenomenon at micro and macro levels [BONITZ, 1997; BONITZ, 2002; BONITZ, & AL., 1999; BONITZ & SCHARNHORST, 2001; BONITZ & AL., 1999], they come to the conclusion that it is a simplistic inference that seems to be unjust. Because, they specified, when reflecting on the related parable in the Gospel, one can perceive that it is a just punishment for those who don't act according to their talents [BONITZ, 1997]. Notwithstanding the fact, the inequalities observed in science are not always believed to have necessarily their roots in reality. For an instance, self-fulfilling prophecy, also called "Thomas theorem", after the name of its introducers [THOMAS & THOMAS, 1928; MERTON, 1995], is one of the phenomena being rooted in false beliefs. According to the proposition "if enough people believe something to be true and act as if it were true, it may eventually become a reality" [LANGE, 2002, PP. 175–176]. That's why the inequities, e.g. towards authors from The South, are sometimes interpreted as the fruits of prejudice and cognitive bias rather than that of the reality [GIBBS, 1995].

The study of the inequalities has brought about prosperous outcomes to scientometrics and research evaluation field. As an example, measuring systematic deviations of observed citation impacts from expected citation impacts of the world's countries, Bonitz and his colleagues succeeded to add another measure for evaluating countries' research performance and called it *Matthew index.* On the basis of this finding, they categorized the world's countries into three groups: right world or citation winners, left world or citation losers, and Middle world or countries with an acceptable scientific performance [BONITZ, 1997; BONITZ, 2002; BONITZ, & AL., 1999]. According to their findings, "a minority of countries, expecting a high number of citations per scientific paper, is gaining even more citations than expected; while the majority of countries, expecting only a low number of citations per scientific paper, is gaining even fewer citations than expected" [BONITZ, 1997, P. 208].

Using a different approach, Katz tried to verify the existence of the phenomenon in science systems. He studied the relationship between recognition (citations) and size (papers) across scientific communities within a science system, science systems for a specific scientific community, and institutions in various sectors within a science system. He found out that a power law relationship exists between the two variables confirming the existence of the *Matthew effect* in recognition processes. He concluded that the non-linearity, being commonly disregarded in traditional indicators, results in an over- and under-estimation of the research performance of both large and small institutions and nations [KATZ, 1999A; 1999B; 2000]. To compensate for the inequity, he proposed an innovative scale-independent indicator called *Adjusted Relative Citation Impact* (ARCI) that takes into account the non-linearity. It is calculated by:

$$ARCI = \frac{Actual\ Impact}{Expected\ Impact} = \frac{Observed\ number\ of\ Citations}{Expected\ number\ of\ Citations}$$

The expected Citations is calculated using the power law relationship:

$$Citations = k \times Papers^{n} \quad ,$$

where k is a constant and n is the exponent of the power law relationship.

Adjusting for the effect of size on recognition, the ARCI indicator helps compare (a) fields of different sizes within the same system and (b) the same field across systems [Katz, 2000].

Katz's power law model puts forward another way to categorize entities, e.g. the world's countries into the three groups proposed by Bonitz and his colleagues. The exponent and standard errors are the two essential data provided by the model that help us illustrate scientific performance of countries within the world science system and in individual disciplines: when the exponent of the power law (n) is greater than one for a country or group of countries, the country or the group of countries are expected to experience a surplus of citations in proportion to their products (right world or winners). If the exponent is less than one, they are expected to gain a disproportionately smaller share of citations as their output increases (left world or losers). In the simplest mode, the exponent equals one, indicating a linear growth of the two variables, no citation win or lose is supposed to happen (middle world with an acceptable performance).

These inequalities generated few investigations directly concentrating on the Matthew phenomenon in the OA science system. As one of the rare instances, if any, the study conducted by ZHAO [2005] on web publishing in XML research field provides some evidence in this regard. She found out that "among those scholars who were publishing on the Web, only very highly visible ones [in terms of publication and citation number] are likely to be recognized by the community" (p. 1409).

Methodology

We chose to study gold OAJs as one of the pillars of OA movement.[1] The identification and validation methods and rationale for the selection of the journals are respectively described in SOTUDEH & HORRI [2007A; 2007B] and are described here in brief.

OA journals identification and validation

To identify Gold open access journals, we used several open access directories including BioMed Central (BMC), Directory of Open Access Journals (DOAJ), Free full text, Electronic Journals Library (EZB), Highwire Press, J-STAGE, Open J-Gate, Scientific Electronic Library Online (SciElo), as well as McVeigh's list of OAJs indexed by ISI [MCVEIGH, 2004; TESTA & MCVEIGH, 2004]. Open access journals are subject to many changes and fluctuations in terms of their access policies and patterns. Therefore, to get reliable outcomes, it is required to concentrate on those being long-lasting, stable, and prestigious. The OAJs were identified and validated according to the following criteria:"Gold", i.e. those journals providing an immediate access to the their entire contents;

1. "long-lasting", i.e. those applying the above mentioned policy for at least five years;
2. "stable", i.e. those experiencing no changes in their full, immediate access policy during these 5 years, and finally;
3. "prestigious" journals, i.e. those indexed by SCI and included in the JCR 2003.

To this aim, we tracked the journals evolution through their web pages recorded by Internet Archive, a service provided by Alexa to harvest the entire Internet[2]. Furthermore, to explore their present status, we verified their current web pages, too. In the case of failure of these two strategies, we tried to get information directly from a person in charge of the related journal. In this way, we reached a list of 139 journals

[1] The two major channels of Open access include Gold and Green OA journals. Gold OA refers to those journals that immediately provide all users with the free access to their entire contents. Green refers to those journals permitting authors to self-archive their papers whether in preprint or post-print format.
[2] www.archive.org/web/web.php

providing an immediate, free access to their entire contents on the basis of a stable policy for at least five years and indexed by SCI. As a prestige criterion, we chose JCR 2003. 114 journals were found to be recognized enough by scientific communities to enter JCR. Furthermore, we omitted non-English journals[3] and those launched after 2001, because non-English articles and those published in new-launched, less-known journals are revealed to be less cited and more likely to distort the results of citation analyses [GARFIELD, 1970; 1972; MEADOWS, 1997]. In this way, we reached a list of 99 prestigious, long-lasting, pure open access journals (Appendix A).

Articles data gathering and preparation

Using Science Citation Index Expanded 3.0 available at Web of Science, we downloaded the related articles, notes and reviews published from 2001 to 2003 in a tab-delimited format in early 2006. In this study, all these document types are referred to as "papers" or "outputs". We then purified, parsed and prepared them for further analyses using excel and SPSS. Totally, 27948 unique, pure OA items were collected.

Papers were assigned to a country if at least one author came from an institution with an address in the county. All numerical analyses used integer counts, i.e. in the case of a collaborative paper (co)authored by scientists from different countries; each of the countries was counted once and all citations received by the article was assigned to each of them. Thus in many cases paper percentages will add up to more than 100. Citations were counted using a variable time window (from 3 years for articles published in 2003 to 5 years for those published in 2001).

Countries classification

In order to have an insight of the countries' scientific and technological development, we used the RAND classification of countries reported by WAGNER & AL. [2001]. Based on an index developed to characterize national S&T investment and output capacity, they categorize countries into four categories:

1. "Scientifically advanced countries" (SAC) – including 22 countries with scientific capacity well above the international mean;
2. "Scientifically proficient countries" (SPC) – including 24 countries which also have positive standing in scientific capacity when compared to the rest of the world;
3. "Scientifically developing countries" (SDC) – including 24 countries with some features of scientific capacity, and where the trend in spending is positive but whose scientific capacity is below the international mean;

[3] Non-English articles of bilingual or multilingual journals were filtered during download process.

4. "Scientifically lagging countries" (SLC) – including 80 countries with little data indicating scientific capacity.

For practical purposes, in this study the three latter groups are sometimes re-categorized into one broader category called "less-developed" to make a distinction between the world's scientifically developed and less-developed blocks.

Subject classification

The data verification showed that of 170 subject categories currently covered by SCI, 67 are covered by the OAJs [SOTUDEH & HORRI, 2007A]. An updated version of the journal classification scheme invented by KATZ & HICKS [1995] was provided and approved by Professor Katz. Using the scheme, the OA papers were classified into four broad scientific disciplines including Life Sciences, Natural Sciences, Engineering & Material Sciences, and Multidisciplinary Sciences according to the field of the journal in which they were published.

In order to find a mathematical model illustrating countries citation performance, we applied regression analysis based on the methodology and rationale described by SOTUDEH & HORRI, [2007A]. As shown in the following sections, the results of the analyses show that a power law relationship provides the best fitted curve to verify the citation behavior of countries relative to their contributions to the OAJ sub-system.

Research questions

In order to achieve the above mentioned aim, this study tries to answer the following questions:

1. To what extent do countries contribute to the OA journal system?
2. What mathematical model does describe citation distributions across the contributing countries in the OA system?
3. How does the citation distribution model vary in different disciplines?
4. To what extent do the contributing countries equal or exceed their expected citation rates in the OA subsystem and in each of the broad disciplines?

Findings

OA articles general features

A list of active countries contributing to and publishing the OAJs is provided in Appendix B. It is noteworthy that the appendix lists only those countries that had at least one OA contribution in each of the studied years and received citations. Tables 1 and 2 provide synopses of the appendix.

Countries as publishers: data verification showed that the OAJs are published by 25 countries (Appendix B). As seen in Table 1, a majority of the long-lasting, prestigious, stable OAJs (57.58 percent) are published by scientifically advanced countries. The rest (42.2 percent) belongs to less-developed block, including scientifically proficient, developing and lagging countries. Bangladesh is the only lagging country in the list. Amongst the less-developed countries, proficient ones like Brazil and India, now pioneering in launching new OAJs [MCVEIGH, 2004], are of majority as regards the publication of the enduring OAJs, too.

Countries as authors: Data verification showed that totally 146 countries (co)authored OA articles. Table 1 illustrates also the distribution of OA articles (co)authored by different scientific blocks. Advanced countries followed by proficient countries gain the lion share of OA articles, as is the case in the global science system, too (see e.g. [SCHUBERT & AL., 1989; BRAUN & AL., 1994A; 1994B; MAY, 1997; KING, 2004]).

Table 1. The distribution of OA journals/articles published by different scientific groups

Status	No. of journals	Percent	No. of articles	Percent
SAC	57	57.58	24246	86.75
SDC	11	11.11	2734	9.78
SLC	1	1.01	839	3.00
SPC	30	30.30	12040	43.08
NA	–	–	54	0.19
Total	99	100.00	39913	142.81*

* The percentages add up to more than 100, due to the existence of internationally collaborated papers

According to Table 2, a high portion of OA articles in each of the four categories remained uncited. Developing countries with 34.82 and lagging countries with 20.50 percent show respectively the highest and the lowest uncitedness rate compared to the two other scientific categories.

Table 2. The distribution of uncited OA articles in different scientific groups in 2001–2003

Scientific status	No.	Percent (in the total uncited article)	Percent (in the block's total share)
SAC	5940	53.92	24.50
SDC	952	8.64	34.82
SLC	172	1.56	20.50
SPC	3938	35.74	32.71
NA	15	0.14	27.78
Total	11017	100.00	27.60

Countries approach to contributing to the OAJs: In order to investigate the publication strategy of the scientific groups regarding the OAJs, we tried to answer two questions: Do the groups show more tendency towards these journals compared to the past? Does the OA articles distribution of each group differ from that of their total publications? In order to answer the first question, we downloaded the data related to articles published in these journals during 1998–2000, following the above mentioned search strategy. The shares of each group are revealed to be almost the same in the two periods (Table 3). This shows that the countries' approach to the OAJs remained unchanged after the journals converted to OA, or got older and hence more well-known. To answer the second question, we tried to find the total share of papers (co)authored by each country in the scientific groups using "CU" command in SCI Expanded. For USA, we used "PS" command – devoted to searching by states or provinces – owing to its huge publication number. Data gathered in Table 3 reveal that countries contribution pattern to the OAJs differs from their overall contribution to the world science system in the same period. Advanced countries have a smaller OA share compared to their overall publications in the same period, while proficient and developing countries witness a higher OA share. This is due to the existence of a great number of indigenous journals in the OA collection; while their overall journal portions are considerably lower [MCVEIGH, 2004]. As a result, not only the journal, but also the article distribution of each group is revealed to differ from its overall journal and article distribution in the ISI databases.

Table 3. The scientific blocks' shares in the OA journals and in world science system

	Publications in the OAJS				Total publications	
	2001–2003		1998–2000		2001–2003	
Status	No.	Percent	No.	Percent	No.	Percent
SAC	24246	60.75	15519	62.45	2,484,348	80.65
SDC	2734	6.85	1456	5.86	91,826	2.98
SLC	839	2.10	405	1.63	39,822	1.29
SPC	12040	30.17	7423	29.87	462,692	15.02
NA	54	0.14	46	0.19	1,645	0.05
Total	39913	100.00	24849	100.00	3,080,333	100.00

OA citation distributions across countries

In order to find a mathematical model describing the citation distribution between the contributing countries, we examined the relationship between article and citation counts across countries year by year in the whole OA system and in each of the broad disciplines. It is worth mentioning that Multidisciplinary Sciences, having only 4 subject categories, was unreliable to be studied individually [SOTUDEH & HORRI, 2007A]. Moreover, of 146 contributing countries, almost half (75 countries) were in an appropriate situation to be included in the study, in that they had at least one OA contribution in each of the studied years and received citations (Appendix B). In order to get more reliable results, we excluded those countries having no contributions in at least one year and those articles gaining no citations, as well.

The results are illustrated in Table 4 and Figures 1–4. It should be mentioned that all of the graphs in this research are plotted based on the natural logs of the papers and citations following the equation Ln(C)= Ln(k) + nLn(P). That is because when two variables are correlated by a power law relationship, their natural logs are correlated by a linear relationship, the slope of which is the exponent of the power curve.

Table 4. The regression analyses data for the power law relationship across countries in the whole OA science system and in each discipline

	Year	R2	df	F	Sig. F	Exponent	SE
Life Sciences	2001	0.87	1,69	478.40	0	1.18	0.05
	2002	0.89	1,69	546.98	0	1.14	0.05
	2003	0.89	1,69	563.47	0	1.23	0.05
Natural Sciences	2001	0.91	1,48	478.50	0	1.12	0.05
	2002	0.90	1,48	460.61	0	1.06	0.05
	2003	0.92	1,48	525.09	0	1.14	0.05
Engineering & Material Sciences	2001	0.78	1,22	78.74	0	1.14	0.13
	2002	0.68	1,22	47.01	0	0.86	0.12
	2003	0.87	1,22	146.81	0	1.07	0.09
The Whole OAJ Science System	2001	0.90	1,73	668.09	0	1.16	0.04
	2002	0.91	1,73	715.56	0	1.1	0.04
	2003	0.92	1,73	840.22	0	1.19	0.04

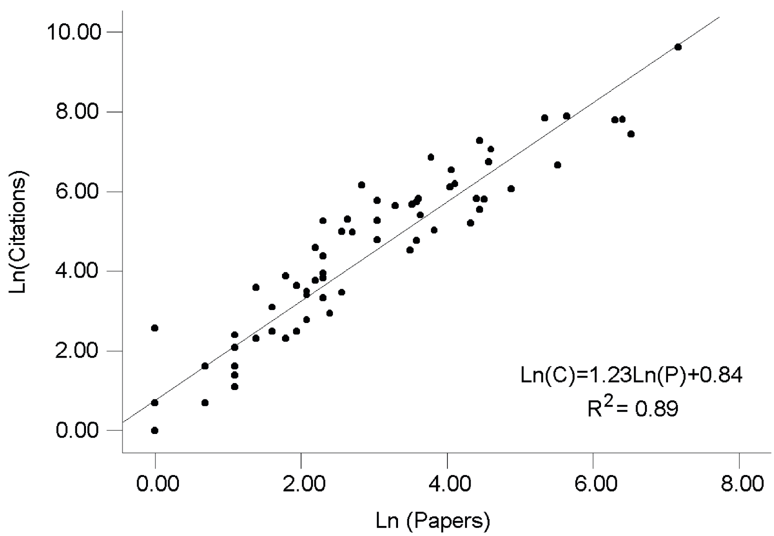

Figure 1. OA papers and citations correlation across countries in Life Sci. in 2003

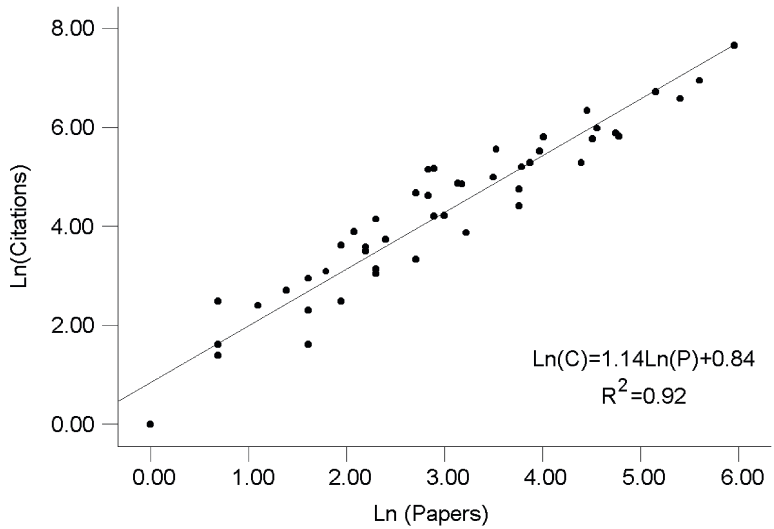

Figure 2. OA papers and citations correlation across countries in Nat. Sci. in 2003

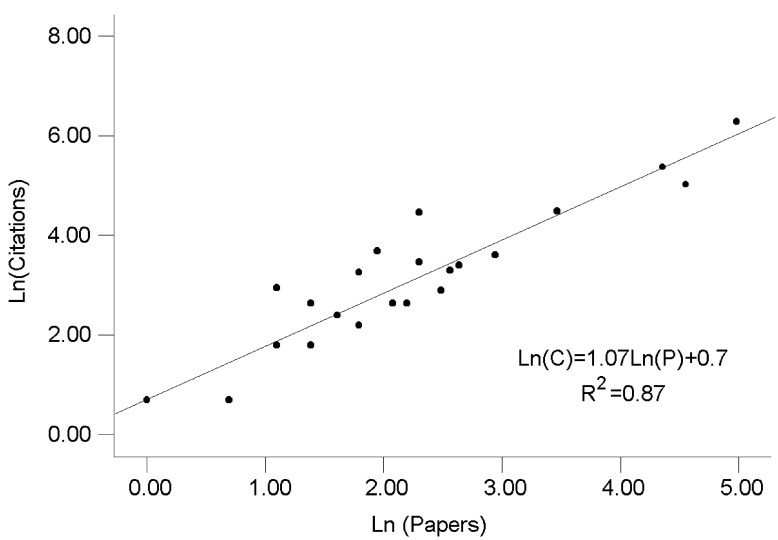

Figure 3. OA papers and citations correlation across countries in Eng. & Mater. Sci. in 2003

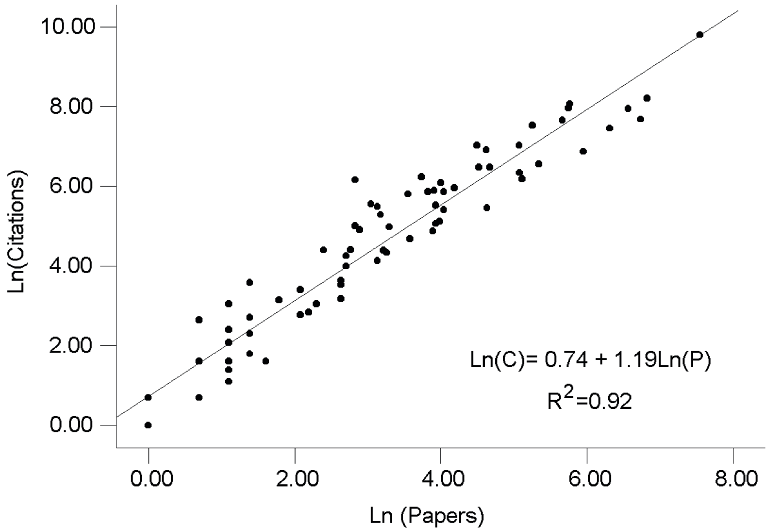

Figure 4. OA papers and citations correlation across countries within the OA system in 2003

Citation distribution between countries in disciplines

Life Sciences: The regression analyses performed for Life Sciences across countries reveal that OA articles and citations are strongly correlated by a power law relationship (Table 4). According to the exponents yielded, the contributing countries seem to perform well in Life Sciences. The exponents are greater than one in each year indicating a very faster change in citation counts relative to the outputs. For example, the exponents yielded for the analysis across countries in year 2003 equal 1.23. It follows from the data that when a country doubles its share in life science-related OAJs, it is expected that on average the amount of its recognition increases by a factor of 2.35 ±0.08 (i.e. $2^{1.23\pm0.05}$). As seen in Table 4, the exponents are lower for years 2001 and 2002 compared to year 2003 with a shorter citation time window. It reveals that the average expected for papers published in this year is higher than what is expected for the two other years; in other words, it disclose the advantage of the most recent articles over the older ones. Figure 1 illustrates the power law relationship between the two variables across countries in year 2003 in Life Sciences.

Natural Sciences: As shown in the data summarized in Table 4, the analyses performed across countries reveal that the exponents are greater than one confirming the existence of a nonlinear citation accumulation trend. Based on these data, if a country's

OA share in Natural Sciences is doubled, the amount of its recognition is expected to increase by a factor of 2.17 ± 0.08, 2.08 ± 0.07 and 2.2 ± 0.08 times in years 2001, 2002 and 2003 respectively. The comparison of the exponents in different years reveals that like the case of Life Sciences, the exponent yielded for year 2003 is the highest favoring the most recent articles. Figure 2 illustrates the power law relationship between the two variables across countries in year 2003 for Natural Sciences.

Engineering & Material Sciences: Figure 3 shows the relationship between paper and citation counts across countries in Engineering & Material Sciences. The data related to the discipline reveal that apart from year 2002 that witnesses the weakest correlation, the two variables are strongly correlated by a power law relationship. However, the correlation coefficients are not as high as those obtained for the two other disciplines. What is more, the anomalies are also seen in the exponent yielded for year 2002. Being lower than one, the exponent implies that the bigger a country's outputs are in this year, the lower is expected to be its share of citations relative to its publication size. Although, the exponents obtained for the two other years are greater than one in favor of countries with higher share of outputs, they are relatively lower than those yielded for the two other disciplines in respective years. On the basis of the analyses results gathered in Table 4, if a country's OA share in Engineering & Material Sciences doubles in year 2003, it is expected that its citation amount increases 2.1 ± 0.13 times, which is lower than the estimated amounts for the two other disciplines in the corresponding year.

Given the exponents and their related standard errors, one can see that contrary to what is observed for the previous cases, the exponent yielded for year 2001 is the highest. One may then assume that OA papers in Engineering & Material Sciences are likely to improve their performance as they get older. Our previous analyses conducted across subject fields in the discipline demonstrated identical results (SOTUDEH & HORRI, 2007a). However, given the weaker correlation observed and the high standard errors, further investigation is required to get more reliable outcomes.

Countries' overall citation performance

Table 4 and Figure 4 illustrate the results of the log-log regression conducted across countries in the whole OA system. Given the exponents and their related standard errors, an increase in OA scientific output of a country is expected to result in gaining even more citations. For instance, let consider countries citation performance in year 2003. According to the related data, if a country doubles its OA share, it is supposed that its citation share augments $2^{1.21 \pm 0.04}$, which leads to an increase equivalent to 2.31 ± 0.06 times. The final point to be mentioned is that the exponents yielded for year 2003 is the highest implying that the most recent papers are expected to gain more citations on average compared to the older ones.

Countries ranking in the OAJs: In order to determine the extent to which the contributing countries equal or exceed their expected citation rates in each of the broad disciplines, we calculated their ARCI values using the results yielded by analyses in each discipline. Based on the analysis conducted for the whole OA system, we calculated also a *scale-independent indicator* (SI) [KATZ, 2000] to determine their relative positioning within the OA subsystem. It is noteworthy that in order to be concise, we only report on the rankings for year 2003. The results are presented in the Appendix B, where the contributing countries are first grouped by their scientific categories and then ordered by their global ranks. Relative citation impact (RCI) values[4] are also provided for comparison purposes. Top ten countries gaining the highest ARCI or RCI values are typed in bold.

Table 5 provides a synopsis of the Appendix B and illustrates the situation of each scientific block regarding the number of contributing and well performing members. Those countries exceeding their expected citation level are characterized as "well-performing countries". As can be seen in the table, a majority of scientifically advanced countries gain ARCI values greater than one. They are of preponderance either in the OA subsystem or in each of the broad disciplines. In total, a great percentage of less-developed countries are situated among the well-performing countries, among them New Zealand, Ghana, Hungary, Greece, Yugoslavia, Colombia, Singapore, Uruguay, Thailand, and Pakistan in Life Sciences; Croatia, Hungary, Portugal, Ukraine, Slovakia, Greece, South Africa and Singapore in Natural Sciences; and Czech Republic and Turkey in Engineering & Material Sciences. (Appendix B). When comparing less-developed blocks, one observes that they are almost of the same percentage in Life Sciences. Proficient countries prevail in Natural Sciences, while developing countries in Engineering & Material Sciences.

Table 5. The frequency of contributing well-performing countries in each scientific block

	Contributing countries				Well performing countries							
	Frequency				Frequency				Percent in the block			
Status	Life Sciences	Natural Sciences	Engineering & Material Sciences	OA System	Life Sciences	Natural Sciences	Engineering & Material Sciences	Whole OA System	Life Sciences	Natural Sciences	Engineering & Material Sciences	OA System
SAC	21	20	15	21	17	16	7	18	80.95	80.00	46.67	85.71
SDC	14	12	3	15	5	1	1	3	35.71	8.33	33.33	20.00
SLC	18	2	0	19	6	0	0	10	33.33	0	0	52.63
SPC	17	16	6	19	6	8	1	7	35.29	50.00	16.67	36.84
NA	1	–	–	1	–	–	–	–	–	–	–	–
Total	71	50	24	75	34	25	9	38	47.89	50.00	37.5	50.67

[4] It is computed using the equation: RCI_i = $country_i$ impact/world impact = I_i/I_w where impact I =citations/papers

According to countries ranking, the first position in Natural Sciences is assigned to Austria followed by Denmark, two advanced countries. Croatia, Hungary, and Portugal are the proficient countries to be found in the top ten countries in the discipline. None of the scientifically developing or lagging nations contributing to Natural Sciences is present among the top ten ones. Among advanced countries, Japan and South Korea are the worst-positioned in Natural Sciences. Germany, Netherlands, and Canada are the three leaders in Engineering & Material Sciences; and Belgium, along with Japan, are revealed to have the base positions among advanced countries contributing to the discipline. Czech Republic is the sole representative of the less-developed block placed among the top ten countries in the discipline. As is expected from the high citation average expected for Life Sciences, top countries in the discipline gain higher ARCI values compared to top countries in the two other disciplines. The leading position in the discipline is occupied by New Zealand, a proficient country followed by Iceland and Hungary. Greece and Ghana are the two other less-developed countries located among top ten countries. Once more, Japan and South Korea are found at the bottom of advanced countries list.

As is the case for other global indicators, the citation indicator depends on a country's relative scientific specialization; so that those countries with high relative publication activity in highly cited fields or disciplines are consequently expected to have a comparative advantage compared to those countries specialized in less prolific fields or disciplines. For example, due to the high citation average expected for Life Sciences, publishing OA papers in this discipline plays a determining factor in countries total ranks in the whole OA system. For instance, New Zealand, Iceland and Hungary, the leaders in Life Sciences, occupy the highest global ranks, too. As another example, Ghana, considered as a lagging country regarding its scientific development, published just 11 OA papers in Life Sciences. Although, the 8th in the discipline, it occupies the second global rank, though with a large distance from the first ranked country in terms of its ARCI magnitude. Comparing Ghana's situation to Australia's and Belgium's provides more clarifications. Gaining the fourth and fifth ranks respectively, the two countries are relatively better located in Life Sciences; however, their ranks in the whole OA system are seriously affected by their weaker contributions in Natural Sciences and in Engineering & Material Sciences. Australia gains the 19th and 20th positions and Belgium occupies 8th and 23rd ranks in the two disciplines, respectively.

Discussion and conclusion

This article discovered some aspects of countries contribution to and performance in the OAJ subsystem. Firstly, it demonstrated that a relatively broad range of countries participate in OA movement whether by universally sharing and maintaining their OAJs, or by submitting their scientific outputs. A large proportion of the enduring, prestigious journals are published by less-developed block including scientifically proficient and developing nations. The distribution differs from the overall distribution of journals indexed by ISI databases. While North America and Western Europe are revealed to publish 90% of ISI journals [MCVEIGH, 2004], their share of the OAJs reduces drastically due to the growing share of peripheral countries. The rise of a pervasive wave of publishing or converting to OAJs in The South was previously confirmed by HAIDER [2005] and MCVEIGH [2004]. Our result highlights their considerable share of mature, long-lasting OAJs and emphasizes their successful commitment to maintain the undertaken role.

The world's countries are revealed to welcome publishing in the OAJs. Due to the existence of a large number of local journals, the proficient and developing blocks' shares of total OA articles seem to be higher – compared to their total publications in the same period – which in turn make the OA percentage of advanced countries reduce. However, none of the scientific blocks are revealed to have particular biases for the OAJs, since their share of OA articles does not appear to have significantly increased after the journals converted to OA or after they got older, and hence, more renowned.

A comparison of the exponent yielded for articles published in different years within the same discipline or within the whole OAJ system reveals that the expected citation averages are the highest for the most current articles. This may be indicative of a tendency towards earlier citations for OA items, as confirmed by previous studies, too [HITCHCOCK & AL., 2002; ODLYZKO, 2002; TESTA & MCVEIGH, 2004; MCVEIGH, 2004]. Except to this is Engineering & Material Sciences, which demonstrates a totally different picture in favor of the oldest ones.

The suggested citation distribution models confirm the existence of a skewed citation distribution across countries contributing to the OAJs, emphasizing that they are witnessing a considerable inequality in terms of their citation amount relative to their outputs within a single discipline, among disciplines, and within the whole OAJ subsystem.

According to the exponents as well as the ARCI values yielded for Life Sciences, there exists a highly disproportionate distribution of citations among countries within the discipline, so that those countries with higher shares are expected to gain even more citations. The finding also reveals that the citation average expected for the countries contributing to the discipline is higher compared to the average expected for those contributing to the Natural or Engineering & Material Sciences. It is even higher than what is obtained for the whole OAJ system. It is not far from expected, given the prolific nature of Life Sciences regarding publishing and referencing norms and practices, as well as its longer tradition in publishing OAJs. On the other hand, the anomalies caused by Engineering & Material Sciences, which is likely to have chaotic effects on the whole system, should not be ignored.

The relatively poorer correlation coefficients and lower exponents in Engineering & Material Sciences signify a different citation behavior of countries in the discipline. This was proven to be the case for the citation distribution across fields in the discipline, too [SOTUDEH & HORRI, 2007A]. It is not very far from expected, owing to its substantial difference in publishing and referencing behavior compared to basic sciences [WELLJAMS-DOROF, 1997]. Moreover, the quality of OAJs has been treated with hesitations and concerns for a long time. It seems, therefore, natural that the differentiation is aggravated in the OAJ subsystem as a new, minor and less-established component of the science system and makes the contributing countries appear to be less prone to accumulate the citation amount that their counterparts in the discipline in the whole science system [KATZ, 2000] would achieve.

The results of the correlation analyses between papers and citations in Natural Sciences indicate that the citations are disproportionately distributed between nations, emphasizing the existence of inequalities between countries within the discipline. Given the rather linearity of the citation distribution between fields within the discipline [SOTUDEH & HORRI, 2007A]; this finding underlines the strength of national inequalities in recognition. According to the exponents and ARCI values related to Natural Sciences (Table 4, and Appendix B), the citation average expected for countries contributing to the discipline is lower than what is expected for those contributing to Life Sciences and at global level, too. These findings also confirm that the differences observed between countries at the global level in the OAJ sub-system depend largely on their specializations, so that those specialized in Life Sciences are expected to gain larger citation amounts on average, while those excelling in Engineering & Material Sciences gain less in comparison.

Regarding the number of well-performing countries, advanced countries are found to have the best performance in each discipline and in the whole OA subsystem. However, the world's scientifically prosperous countries, e.g. Canada, France, UK, and USA, traditionally known as scientific leaders (see e.g. [BRAUN & AL., 1994A; 1994B; MAY, 1997; KING, 2004]), are found to have a behavior far from expected. Although, they are revealed to stand out in Engineering & Material Sciences, they fail to position on the top in the whole OA system or in the two other disciplines. The causes of their relatively weaker performance in Life or Natural Sciences are not definitely discernible from the data. It is to some extent related to the applied methodological approach that taking into account the non-linear characteristic of the science system, reflects a picture totally different from that projected by traditional methods. The RCI values presented for countries in each discipline, positioning some of the leaders on top, underline the methodological effect. Moreover, the effects of common hesitations of scientific community towards the journals reputation and the official recognition and validation of papers published by them [see e.g. SWAN & BROWN, 2004A; 2004B] are likely to play a role. This may, on the one hand, affect the citation accumulations, and on the other, discourage scientists from submitting their high quality papers. Further investigation is required to precisely illuminate the causes.

The unsatisfactory positions of some less-developed countries are worth mentioning. Although, a high number of less-developed countries are shown to perform well, some rising scientific nations such as Brazil, Chile, India, and China [RAO, 2001] are revealed to be unsuccessfully located in OA system. This is surprising especially in that the nations have recently been witnessing considerable developments in their science systems and are consequently called Peripheral Scientific Centers [RAO, 2001]. Furthermore, the first three countries, actively producing OAJs or developing open archives, are considered as OA pioneers [CHAN & KIRSOP, 2001; CHAN & COSTA, 2005; ROCHA-E-SILVA, 2006]. Besides, a large number of the long-lasting, prestigious OAJs in the collection are their national journals (Appendix B) that were proven to experience a substantial growth in impact [ROCHA-E-SILVA, 2006]. All these factors would lead to expect a greater visibility and thereby an improved performance for their local research. However, verifying their positions in the table, we astonishingly notice that in spite of their copious contributions, they perform very far below their expected level.

This gives rise to some questions: are these countries experiencing exacerbated positions, e.g. compared to their situation in NOA part of the science system, with a relatively lower readership? If so, is it caused by the fact that the countries' submissions to OAJs are – or perceived to be – of relatively lower quality? In order to provide reasonable explanations to these questions, it is necessary to explore countries scientific positions in the whole science system or more specifically in NOA sub-system and then compare it to their positions in OA sub-system applying the same methodology. Further analysis carried out after – but published prior to – the present paper, chose the latter approach to investigate it [SOTUDEH & HORRI, 2008]. According to the results, the unsatisfactory positioning of the third world in OA journals is not reflecting their total science system, but just what is concerned to OA journals. This leads us to conclude that, in general, authors from less-developed countries may prefer to submit their high quality papers to more renowned journals. Besides, one may not ignore the role of other determining factors like the journals' comparatively lower reputation and the low quality commonly perceived for less-developed countries' outputs that may offset probable positive effects of a wider visibility. Whatever may be the cause, given the high number of the countries' outputs in their national OAJs this finding show that increasing the quantity of scientific outputs is a sine qua non not per se adequate to improve the scientific performance.

*

We would like to cordially thank Professor S. Harnad from UQAM and J. S. Katz from University of SUSSEX for their insightful comments. Valuable collaboration from Professor M. Carl Drott from Drexel University is gratefully acknowledged. The first author acknowledges support from Iranian Information & Communication Technology ministry.

References

ANTELMAN, K. (2004), Do OA articles have a greater research impact? *College & Research Libraries,* 65 (5) : 372–382. Retrieved May 3, 2005, from http://eprints.rclis.org/archive/00002309/.

BONITZ, M. (1997), The scientific talents of nations. *Libri*, 47 : 206–213.

BONITZ, M. (2002), Ranking of nations heightened competition in Matthew Core journals: two faces of the Matthew effect for countries. *Library Trends*, 50 (3) : 440–460.

BONITZ, M., BRUCKNER, E., SCHARNHORST, A. (1999), The Matthew index: Concentration patterns and Matthew core journals. *Scientometrics*, 44(3) : 361–378.

BONITZ, M., SCHARNHORST, A. (2001), Competition in science the Matthew core journals. *Scientometrics,* 51 (1) : 37–54.

BONITZ, M., BRUCKNER, E., SCHARNHORST, A., PERITZ B. C., EGGHE L. (1997), Characteristic impact of the Matthew effect for countries. *Scientometrics*, 40 (3) : 407–422.

BORGMAN, C., FURNER, J. (2002), Scholarly communication bibliometrics. *Annual Review of Information Science Technology*, 36, Medford, NJ: Information Today Inc., pp. 3–72.

BRAUN, T., GLÄNZEL, W., MACZELKA, H., SCHUBERT, A. (1994a), World science in the eighties: national performances in publication output citation impact, 1985–89 versus 1980–1984, Part I. All science fields combined, physics chemistry. *Scientometrics*, 29 (3) : 299–334.

BRAUN, T., GLÄNZEL, W., MACZELKA, H., SCHUBERT, A. (1994b), World science in the eighties: national performances in publication output citation impact, 1985–89 versus 1980–1984, Part II. life sciences, engineering mathematics. *Scientometrics*, 31 (1) : 3–30.

BRAUN, T., GLÄNZEL, W., SCHUBERT, A. (1985), *Scientometric Indicators. A 32-Country Comparative Evaluation of Publishing Performance Citation Impact,* World Scientific Publ. Co., Singapore – Philadelphia.

BRAUN, T., GLÄNZEL, W., SCHUBERT, A. (1987), One more version of the facts figures on publication output relative citation impact of 107 countries, 1978–1980, *Scientometrics,* 11 : 9–15.

BRAUN, T., GLÄNZEL, W., SCHUBERT, A. (1988a), The newest version of the facts figures on publication output relative citation impact of 100 countries, 1981–1985, *Scientometrics*, 13 : 181–188.

BRAUN, T., GLÄNZEL, W., SCHUBERT, A. (1988b), The newest version of the facts figures on publication output relative citation impact in the life Sciences chemistry, 1981–1985, *Scientometrics*, 14 : 3–15.

BRAUN, T., GLÄNZEL, W., SCHUBERT, A. (1988c), The newest version of the facts figures on publication output relative citation impact in physics, engineering, mathematics, 1981–1985, *Scientometrics*, 14 : 365–382.

BRAUN, T., GLÄNZEL, W., SCHUBERT, A. (1989), The newest version of the facts figures on publication output relative citation impact. A collection of relational charts, 1981–1985, *Scientometrics*, 15 : 13–20.

BRAUN, T., GLÄNZEL, W., SCHUBERT, A. (1993), Scientometric indicators datafiles, 1980–1989, *Scientometrics*, 28 : 137–150.

BRODY, T., STAMERJOHANNS, H., HARNAD, S., GINGRAS, Y., VALLIERES, F., OPPENHEIM C. (2004), The effect of OA on citation impact. Presented at: *National Policies on OA (OA), Provision for University Research Output: an International meeting.* Southampton University, Southampton UK. 19 February 2004. Retrieved April 25, 2005, from http://opcit.eprints.org/feb19prog.html.

BROWN, C. (2004), The Matthew Effect of the Annual Reviews series the flow of scientific communication through the world wide web. *Scientometrics*, 60 (1) : 25–36

BROWN, C. M. (2001a), The coming of age of E-prints in the literature of physics. *Issues in Science Technology Librarianship*, 31 (Summer), Retrieved August 3, 2004, from http://www.istl.org/01–summer/.

BROWN, C. M. (2001b), The E-volution of preprints in the scholarly communication of physicists astronomers. *Journal of the American Society for Information Science*, 52 (3) : 187–200.

BROWN, C. M. (2003), The role of electronic preprints in chemical communication: Analysis of citation, usage, acceptance in the journal literature. *Journal of the American Society for Information Science Technology*, 54 (5) : 362–371.

CHAN, L., COSTA, S. (2005), Participation in the global knowledge commons: challenges and opportunities for research dissemination in developing countries. *New Library World*, 106 (1210/1211) : 141–163.

CHAN, L., KIRSOP, B. (2001), Open Archiving opportunities for developing countries: Towards equitable distribution of global knowledge. *Ariadne,* 30, Retrieved October 2, 2005 from http://www.ariadne.ac.uk./issue30/oai-chan/.

COLE, S. (1992), *Making Science. Between Nature and Society.* Harvard University Press, Cambridge, MA.

COLE, S. (2000), The role of journals in the growth of scientific knowledge. In: CRONIN, B. ATKINS, H. O. (Eds), *The Web of Knowledge: A Festschrift in Honour of Eugene Garfield*, Information Today, Inc. Medford, NJ, pp. 102–142.

EYSENBACH, G. (2006a). Citation advantage of open access articles. *PLoS Biology*, 4 (5) : e157.

EYSENBACH, G. (2006b). The open access advantage, *Journal of Medical Internet Research*, 8 (2) : e8. Retrieved October 12, 2006, from http: //www.jmir.org/2006/2/e8/.

GARFIELD, E. (1970), Citation indexing for studying science. *Nature,* 227 : 669–671.

GARFIELD, E. (1972), Citation analysis as a tool in journal evaluation. *Science*, 178 : 471–479.

GIBBS, W. W. (1995), Lost science in the Third World, *Scientific American*, 273 (2) : 76–83.

HAIDER, J. (2005), *The Geographic Distribution of Open Access Journals*. Retrieved January 1, 2006, from http://dlist.sir.arizona.edu/939/01/icml9%5Fposter%5Fhaider.pdf.

HAJJEM, C., GINGRAS, Y., BRODY T., CARR, L., HARNAD, S. (2005A), *Open Access to Research Increases Citation Impact.* Retrieved September, 10, 2005, from http://eprints.ecs.soton.ac.uk/11687/01/chawki2.doc/.

HAJJEM, C., HARNAD, S., GINGRAS, Y. (2005), Ten-year cross-disciplinary comparison of the growth of OA how it increases research citation impact. *IEEE Data Eng. Bull*. 28 (4) : 39–46. Retrieved January 24, 2006, from http://sites.computer.org/debull/A05dec/hajjem.pdf.

HARNAD, S., BRODY, T. (2004), Comparing the impact of OA (OA), vs. Non-OA articles in the same journals. *D-lib Magazine*, 10. Retrieved February 7, 2005, from http://www.dlib.org/dlib/june04/harnad/06harnad.html.

HARNAD, S. (2003), The research-impact cycle. *Information Services & Use*, 23 : 139–142.

HARNAD, S., BRODY, T., VALLIERES, F., CARR, L., HITCHCOCK, S., GINGRAS, Y, OPPENHEIM, C., STAMERJOHANNS, H., HILF, E. (2004), The access/impact problem the green gold roads to OA. *Serials Review* 30 (4), Retrieved May 4, 2005, from http://dx.doi.org/10.1016/j.serrev.2004.09.013.

HILGARTNER, S. (1995), Biomolecular databases: New communication regimes for biology? *Science Communication*, 17 (2) : 240–263.

HITCHCOCK, S., BERGMARK, D., BRODY, T., GUTTERIDGE, C., CARR, L., HALL, W., LAGOZE, C., HARNAD, S. (2002), Open Citation Linking: the way forward. *D-Lib Magazine*, 8 (Oct.), Retrieved March 13, 2005, from http://www.dlib.org/dlib/october02/hitchcock/10hitchcock.

HITCHCOCK, S., BRODY, T., GUTTERIDGE, C., CARR, L., HARNAD, S. (2003), *The Impact of OAI-based Search on Access to Research Journal Papers*. Retrieved September 10, 2005 from http://opcit.eprints.org/serials-short/serials11.html.

KATZ, J. S., HICKS, D. (1995), The classification of interdisciplinary journals: A new approach. *Proceeding of The Fifth Biennial Conference of the International Society for Scientometrics & Informetrics,* Rosary College, River Forest, Il, USA, June 7–10, 1995. Retrieved September 5, 2004, from www.sussex.ac.uk/Users/sylvank/pubs/ClassInterdiscJournals.pdf.

KATZ, J. S. (1999a), The self similar science system, *Research Policy*, 28 : 501–517. Retrieved July 3, 2004, from http://www.sussex.ac.uk/spru/jskatz.

KATZ, J. S. (1999b), *Bibliometric Indicators the Social Sciences, Prepared for the ESRC*. Retrieved July 3, 2004, from http://www.sussex.ac.uk/spru/jskatz.

KATZ, J. S. (2000), Scale-independent indicators research evaluation, *Science Public Policy*, 24 (1) : 23–36 (14), Retrieved July 3, 2004, from http://www.sussex.ac.uk/spru/jskatz.

KING, D. A. (2004), Scientific wealth of nations, *Nature*, 430 : 311–316.

KURTZ, M. J., EICHHORN, G., ACCOMAZZI, A., GRANT, C. S, DEMLEITNER, M., HENNEKAN E., MURRAY, S. S. (2005), The effect of use & access on citations. *Information Processing & Management*, 41 (6) : 1395–1402 . Retrieved November 17, 2005, from http://arxiv.org/abs/cs.DL/0503029.

KURTZ, M. J., EICHHORN, G., ACCOMAZZI, A., GRANT, C. S., DEMLEITNER, M., MURRAY, S. S., MARTIMBEAU, N. ELWELL, B. (2004a), The bibliometric properties of article readership information, *Journal of the American Society for Information Science Technology*, 56 (2) : 111–128.

KURTZ, M. J., EICHHORN, G., ACCOMAZZI, A., STERN–GRANT, C., DEMLEITNER, M., MURRAY, S. S. (2004b), Worldwide use impact of the NASA Astrophysics Data System digital library. *Journal of the American Society for Information Science*, 56 (1) : 36–45. Retrieved May 3, 2005, from http://cfa-www.harvard.edu/~kurtz/jasist1.pdf.

LANGE, L. L. (2002), The impact factor as a phantom: Is there a self–fulfilling prophecy effect of impact. *Journal of Documentation*, 58 (2) :175–184.

MACROBERTS, M. H., MACROBERTS, B. R. (1996), Problems of citation analysis. *Scientometrics*, 36 (3) : 435–444.

MACROBERTS, M. H., MACROBERTS, B. R. (1989), Problems of citation analysis: A critical review. *Journal of the American Society for Information Science*, 40 (5) : 342–349.

MAY, R. M. (1997), The scientific wealth of nations. *Science*, 275 : 793–796.

MCCAIN, K. W. (2000), Sharing digitized research–related information on the World Wide Web. *Journal of the American Society for Information Science Technology*, 51 (14) : 1321–1327.

MCVEIGH, M. E. (2004), *Open Access Journals in the ISI Citation Databases: Analysis of Impact Factors Citation Patterns*. A citation study, from Thomson Scientific (Document technique), Thomson Scientific. Retrieved May 2, 2005, from
http://www.isinet.com/media/presentrep/essayspdf /openaccesscitations2.pdf.

MEADOWS, J. (1997), Can we really see where electronic journals are going? *Library Management*, 18 (3) : 151–154.

MERTON, R. K. (1968), The Matthew effect in science. *Science*, 159 (3810) : 56–63.

MERTON, R. K. (1988), The Matthew effect in science II: Cumulative advantage the symbolism of intellectual property. *ISIS* 79 : 606–623.

MERTON, R. K. (1995), The Thomas theorem and the Matthew effect. *Social Forces*, 74 (2) : 379–424.

NICHOLAS, D., HUNTINGTON P., ROWLANDS, I. (2005), Open access journal publishing: the views of some of the world's senior authors. *Journal of Documentation*, 61 (4) : 497–519.

ODLYZKO, A. M. (2002), The rapid evolution of scholarly communication. *Learned Publishing*, 15 (1) : 7–19. Retrieved May 3, 2005, from http://www.catchword.com/alpsp/09531513/v15n1/contp1-1.htm.

RAO, C. N. R. (2001), Science in the rising nations [editorial]. *Current Science*, 81 (8) : 915–916.

ROCHA-E-SILVA, M. (2006), Publishing science in developing countries. *CLINICS*, 61(5) :375–380.

SCHUBERT, A., GLÄNZEL, W., BRAUN, T. (1989), Scientometric datafiles. A comprehensive set of indicators on 2649 journals 96 countries in all major science fields subfields, 1981–1985, *Scientometrics*, 16 : 3–478.

SOTUDEH, H., HORRI, A. (2007a), The citation performance of open access journals: a disciplinary investigation of citation distribution models. *Journal of the American Society for Information Science & Technology*, 58 (13) : 2145–2156.

SOTUDEH, H., HORRI, A. (2007b), Tracking open access journals evolution: Some considerations in OA data collection validation. *Journal of the American Society for Information Science & Technology*, 58 (11) : 1578–1585.

SOTUDEH, H., HORRI, A. (2008), Great expectations: the role of open access in improving countries' recognition. *Scientometrics* 76 (1) : 69–93

SWAN, A., BROWN, S. (2004a), Authors open access publishing. *Learned Publishing*, 17 (3) : 219–224.

SWAN, A., BROWN, S. (2004b), *JISC/OSI Journal Authors Survey Report*. Truro, Key Perspectives Ltd. Retrieved September 22, 2004, from http://wwww.jisc.ac.uk/uploaded_documents/JISCOAreport1.pdf.

TESTA, J. MCVEIGH, M. E. (2004), *The Impact of Open Access Journals: A Citation Study*, from Thomson ISI. Retrieved December 12, 2004, from http://isinet.com/media/presentrep/acropdf/impact-oa-journals.pdf.

THOMAS, W. I., THOMAS, D. S. (1928), The childe in America: Behavior problems programs, Alfred A. Knopf, New York, NY. In: LANGE, L. L. (2002), *The Impact Factor as a Phantom: Is there a Self-Fulfilling Prophecy Effect of Impact. Journal of Documentation*, 58 (2) :175–184.

WAGNER, C. S., BRAHMAKULAM, L. JACKSON, B,. WONG A. YODA T. (2001), *Science Technology Collaboration: Building Capacity in Developing Countries?* MR-1357-0-WB. Santa Monica, CA. Rand Science Technology. Retrieved August 27, 2004, from www.rand.org/

WARR, W. A. (2003), Evaluation of an experimental chemistry preprint server. *Journal of Chemical Information Computer Science*, 43 : 362–373.

WELLJAMS-DOROF, A. (1997), Quantitative citation data as indicators in science evaluations: A primer on their appropriate use. In: M. S. FRANKEL & CAVE J. (Eds), *Evaluating Science & Scientists. An East-West Dialogue on Research Evaluation in Post-communist Europe.* Budapest: Central European University Press.

YOUNGEN, G. K. (1998), Citation patterns to traditional electronic preprints in the published literature. *College & Research Libraries*, 59 (5) : 448–456.

ZHAO, D. (2005), Challenges of scholarly publications on the Web to the evaluation of science – A comparison of author visibility on the web in print journals. *Information Processing & Management*, 41: 1403–1418.

Appendix A: The list of long-lasting OA journals indexed in SCI

1	*Acta Chimica Slovenica*	51	*Journal of Biochemistry and Molecular Biology*
2	*Acta Neurobiologiae Experimentalis*	52	*Journal of Biosciences*
3	*Acta Physica Polonica B*	53	*Journal of Clinical Investigation*
4	*Acta Protozoologica*	54	*Journal of Health Population and Nutrition*
5	*Acta Veterinaria Brno*	55	*Journal of Health Science*
6	*Advances in Physiology Education*	56	*Journal of Korean Medical Science*
7	*American Family Physician*	57	*Journal of Nephrology*
8	*Anais da Academia Brasileira de Ciencias*	58	*Journal of Nonlinear Mathematical Physics*
9	*Analytical Sciences*	59	*Journal of Pharmacy and Pharmaceutical Sciences*
10	*Annals of Agricultural and Environmental Medicine*	60	*Journal of Psychiatry & Neuroscience*
11	*Annals of Mathematics*	61	*Journal of Radiation Research*
12	*Applied Entomology and Zoology*	62	*Journal of Rehabilitation Research and Development*
13	*Archivos de Medicina Veterinaria*	63	*Journal of Research of the National Institute of Standards and Technology*
14	*Archivos Latinoamericanos de Nutricion*	64	*Journal of the Brazilian Chemical Society*
15	*Arquivos de Neuro-Psiquiatria*	65	*Journal of the Meteorological Society of Japan*
16	*Biological & Pharmaceutical Bulletin*	66	*Journal of the Serbian Chemical Society*
17	*Biological Research*	67	*Journal of Veterinary Medical Science*
18	*Biotechnology and Development Monitor*	68	*JSME International Journal Series A-Solid Mechanics and Material Engineering*
19	*Boletin de la Sociedad Chilena de Quimica*	69	*JSME International Journal Series B-Fluids and Thermal Engineering*
20	*Brazilian Journal of Chemical Engineering*	70	*JSME International Journal Series C-Mechanical Systems Machine Elements and Manufacturing*
21	*Brazilian Journal of Medical and Biological Research*	71	*Leprosy Review*
22	*Brazilian Journal of Microbiology*	72	*Memorias do Instituto Oswaldo Cruz*
23	*Brazilian Journal of Physics*	73	*Molecular Vision*
24	*Breeding Science*	74	*Mount Sinai Journal of Medicine*
25	*Bulletin of the American Mathematical Society*	75	*MRS Internet Journal of Nitride Semiconductor Research*
26	*Bulletin of the Korean Chemical Society*	76	*New Journal of Physics*
27	*Bulletin on the Rheumatic Diseases*	77	*Oncologist*
28	*Canadian Family Physician*	78	*Optics Express*
29	*Canadian Journal of Surgery*	79	*Pesquisa Agropecuaria Brasileira*
30	*Canadian Medical Association Journal*	80	*Physical Review Special Topics-Accelerators and Beams*
31	*Caribbean Journal of Science*	81	*Physician and Sportsmedicine*
32	*Ceramics-Silikaty*	82	*Polish Journal of Pharmacology*
33	*Chinese Medical Journal*	83	*Proceedings of the Indian Academy of Sciences-Chemical Sciences*
34	*Cleveland Clinic Journal of Medicine*	84	*Proceedings of the Indian Academy of Sciences-Earth and Planetary Sciences*
35	*Croatian Medical Journal*	85	*Proceedings of the Indian Academy of Sciences- Mathematical Sciences*
36	*Current Science*	86	*Revista Chilena de Historia Natural*
37	*Ecletica Quimica*	87	*Revista Geologica de Chile*
38	*Electronic Research Announcements of the American Mathematical Society*	88	*Revista Medica de Chile*
39	*Emerging Infectious Diseases*	89	*Sadhana-Academy Proceedings In Engineering Sciences*
40	*ETRI Journal*	90	*Silva Fennica*
41	*Fishery Bulletin*	91	*Surgeon Journal of the Royal Colleges of Surgeons of Edinburgh and Ireland*
42	*Florida Entomologist*	92	*Swiss Medical Weekly*
43	*Genetics and Molecular Biology*	93	*Taiwanese Journal of Mathematics*
44	*Gold Bulletin*	94	*Turkish Journal of Chemistry*
45	*IBM Journal of Research and Development*	95	*Turkish Journal of Veterinary & Animal Sciences*
46	*IBM Systems Journal*	96	*Veterinarni Medicina*
47	*Interciencia*	97	*World Journal of Gastroenterology*
48	*Israel Medical Association Journal*	98	*Yakugaku Zasshi-Journal of the Pharmaceutical Society of Japan*
49	*Japanese Journal of Pharmacology*	99	*Yonsei Medical Journal*
50	*Journal of Artificial Intelligence Research*		

Appendix B: Countries ranked by their ARCI values in the OA system and in Broad Disciplines according to their Rand Status

Global Rank	Country	No. of OAJs	OA Outputs	Life Sciences		Natural Sciences		Engineering & Material Sciences		OA science system
				ARCI	RCI	ARCI	RCI	ARCI	RCI	SI
				Scientifically Advanced Countries (SAC)						
4	**Iceland**	–	6	5.6	1.79	–	–	–	–	**2.94**
5	**Denmark**	–	141	3.28	2.11	2.81	2.28	–	–	**2.84**
6	**Belgium**	–	146	3.37	1.97	1.74	1.23	0.47	0.35	**2.75**
8	**Australia**	–	334	3.91	2.97	1.18	1.04	0.66	0.53	**2.54**
10	**Austria**	–	94	2.7	1.55	2.93	2.36	0.99	0.7	**2.3**
14	**Switzerland**	1	544	2.02	1.64	2	1.77	1.89	1.52	**1.94**
15	**Sweden**	1	240	1.72	1.26	1.72	1.39	–	–	**1.79**
16	**Finland**	1	183	1.64	1.19	1.16	0.86	–	–	**1.75**
17	**France**	–	772	2.59	2.3	0.95	0.97	0.97	0.77	**1.72**
19	**UK**	4	1329	1.53	1.67	1.52	1.54	0.66	0.55	**1.58**
20	**Canada**	5	1494	1.11	1.3	1.57	1.32	2.47	2.01	**1.45**
22	**Netherlands**	1	345	1.35	1.1	1.47	1.24	2.9	2.23	**1.43**
25	**Taiwan**	1	351	1.64	1.18	1.18	0.89	0.62	0.53	**1.37**
27	**Norway**	–	44	1.32	0.71	1.36	0.86	–	–	**1.33**
29	**Italy**	1	616	1.31	1.19	1.17	1.1	1.35	1.13	**1.28**
30	**Russia**	–	267	1.24	0.66	1.48	1.4	–	–	**1.26**
33	**Germany**	–	1075	1.74	1.6	1	1.12	3.67	3.06	**1.18**
35	**USA**	24	7403	0.97	1.6	1.02	1.27	1.28	1.3	**1.08**
53	Israel	1	791	0.45	0.45	2.1	1.66	0.86	0.73	0.64
64	Japan	13	5328	0.45	0.61	0.75	0.89	0.58	0.56	0.51
69	S. Korea	4	2743	0.38	0.43	0.66	0.76	1.01	0.98	0.45
				Scientifically Proficient Countries (SPC)						
1	**New Zealand**	–	45	6.24	3.82	–	–	–	–	**7.75**
3	**Hungary**	–	79	4.9	2.65	1.97	1.47	–	–	**3.28**
13	**Greece**	–	69	2.86	1.51	1.27	0.93	–	–	**2.07**
18	**Singapore**	1	104	2.1	1.43	1.07	0.87	–	–	**1.64**
21	**Portugal**	–	55	1.1	0.57	1.97	1.43	–	–	**1.45**
24	**Ukraine**	–	40	–	–	1.33	0.87	–	–	**1.38**
32	**Spain**	–	366	1.34	1.08	1.04	0.96	–	–	**1.19**
43	Slovenia	1	149	0.71	0.33	0.96	0.79	–	–	0.83
44	South Africa	–	95	0.78	0.34	1.23	0.86	0.67	0.53	0.79
46	Croatia	1	201	0.54	0.38	2.35	1.4	–	–	0.72
47	Slovakia	–	134	0.59	0.34	1.31	0.89	0.47	0.35	0.71
48	Czech Rep.	3	313	0.61	0.45	0.72	0.54	1.57	1.23	0.7
52	Romania	–	58	–	–	0.56	0.4	–	–	0.65
57	Poland	5	1077	0.64	0.56	0.63	0.66	–	–	0.58
58	China	2	2505	0.4	0.56	0.8	0.82	0.75	0.62	0.55
63	Lithuania	–	14	0.86	0.14	–	–	–	–	0.52
72	Cuba	–	43	0.33	0.14	–	–	–	–	0.39
73	India	6	2205	0.55	0.5	0.57	0.57	0.88	0.75	0.38
75	Brazil	11	4432	0.24	0.34	0.69	0.73	0.78	0.69	0.34

Appendix B: Countries ranked by their ARCI values in the OA system (continued)

Global Rank	Country	No. of OAJs	OA Outputs	Life Sciences		Natural Sciences		Engineering & Material Sciences		OA science system
				ARCI	RCI	ARCI	RCI	ARCI	RCI	SI
	Scientifically Developing Countries (SDC)									
9	**Colombia**	–	115	2.24	1.33	0.78	0.47	–		**2.45**
34	**Mexico**	–	228	1.1	0.81	0.66	0.49	–	–	**1.1**
38	**Pakistan**	–	56	1.5	0.75	0.69	0.47	0.92	0.7	**1.03**
39	Kuwait	–	13	0.86	0.27	–	–	–	–	0.96
42	Iran	–	134	0.48	0.23	1.03	0.96	–	–	0.87
45	Egypt	–	105	1.17	0.63	0.55	0.44	0.99	0.7	0.75
50	Argentina	–	275	0.59	0.45	0.69	0.47	–	–	0.69
51	Bolivia	–	22	0.56	0.23	–	–	–	–	0.65
55	Yugoslavia	1	245	2.28	1.1	0.49	0.45	–	–	0.61
56	Indonesia	–	44	0.47	0.24	0.98	0.58	–	–	0.6
59	Costa Rica	–	26	0.45	0.18	–	–	–	–	0.55
60	Turkey	2	909	0.46	0.41	0.68	0.62	1.08	0.98	0.53
65	Venezuela	2	113	0.43	0.24	0.78	0.47	–	–	0.5
68	Latvia	–	3	–	–	0.43	0.23	–	–	0.48
70	Chile	6	405	0.38	0.33	0.53	0.45	–	–	0.45
	Scientifically lagging Countries (SLC)									
2	**Ghana**	–	11	2.82	1.24	–	–	–	–	**3.31**
7	**Bosnia & Herceg.**	–	13	0.43	0.14	–	–	–	–	**2.72**
11	**Uruguay**	–	32	2.03	1.1	–	–	–	–	**2.23**
12	**Thailand**	–	90	1.98	1.27	0.43	0.23	–	–	**2.15**
23	**Malawi**	–	14	1.23	0.5	–	–	–	–	**1.42**
26	**Bangladesh**	1	64	1.22	0.78	–	–	–	–	**1.37**
28	**Malaysia**	–	32	1.31	0.6	–	–	–	–	**1.3**
31	**Peru**	–	30	1	0.52	–	–	–	–	**1.21**
36	**Vietnam**	–	16	0.92	0.34	–	–	–	–	**1.05**
37	**Kenya**	–	25	0.89	0.37	–	–	–	–	**1.04**
40	Tanzania	–	8	0.86	0.27	–	–	–	–	0.96
41	Paraguay	–	12	0.78	0.34	–	–	–	–	0.92
49	Saudi Arabia	–	63	0.71	0.38	–	–	–	–	0.7
54	Ethiopia	–	36	0.53	0.27	–	–	–	–	0.64
61	Philippines	–	25	0.37	0.27	–	–	–	–	0.52
62	Morocco	–	10	0.43	0.14	–	–	–	–	0.52
66	Ecuador	–	11	0.43	0.14	–	–	–	–	0.48
67	UAE	–	15	0.43	0.14	–	–	–	–	0.48
74	Jordan	–	26	–	–	0.34	0.23	–	–	0.35
	NA									
71	Fr. Guiana	–	6	0.37	0.14	–	–	–	–	0.42
	* Other	–	451							
	Total	99	39913							

* Countries with no contributions in at least one year or gaining no citations are grouped in "other".