

The Open Access citation advantage

Studies and results to date

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Abstract

This paper presents a summary of reported studies on the Open Access citation advantage. There is a brief introduction to the main issues involved in carrying out such studies, both methodological and interpretive. The study listing provides some details of the coverage, methodological approach and main conclusions of each study.

The hypothesis

Early studies on the Open Access (OA) citation advantage set out to test the hypothesis that OA, by increasing visibility, findability and accessibility for research articles, would increase citations made to those articles; that is, it would increase research impact over and above the impact already gained through the subscription-access system. The expectations were that it would increase usage since one reason for Open Access is that it allows research findings to reach the hitherto unreached who would then be able to make use of those findings in the normal way, which is to read and build upon them.

The expectations

It is worth explaining those expectations in a little more detail because it provides more context to the review of the studies so far carried out and helps in the interpretation of their findings.

The original aim was to test whether there was an overall rise in citations for an Open Access body of literature. There certainly was not, even early on, an expectation amongst the thinkers on this topic that OA can work magic and make the uncitable suddenly citable. Citability rests upon the quality, relevance, originality and influence of a piece of work. Research reports that add little or nothing to development or thinking in a field earn little or no attention from other researchers, even if they can be readily accessed.

So the expectations, in essence, derived from a set of logical assumptions:

- that a proportion (whose size varies according to discipline or field) of researchers do not have access through subscription journals to all the published papers that are relevant to, and might influence, their own work
- that these people would avail themselves of the opportunity to access and read these otherwise unavailable documents if they were made freely available online
- that some of those documents would be found to be relevant and applicable to the researchers' work and hence citable

- that others would be found to be irrelevant or inapplicable and would not be cited for the usual reasons that work is not cited

In other words, the expectation was that this hitherto inaccessible body of literature would be as varied in its utility and influence as its counterpart in the already-accessible subscription literature. Some articles would prove to be citable; others would not. That OA would produce an automatic citation boost for every article was never the expectation. There was, however, the expectation that OA would raise the level of readership and provide a resultant citation boost wherever merited, just as if all the world's academic libraries suddenly and exuberantly subscribed to all the world's academic literature.

The expectation was also that the citation boost would vary in magnitude with discipline and with time, since citing behaviour in general varies on both these parameters. Thus a blanket 'OA boost' to citations of, say, 50% was never considered probable. Instead, it seemed likely that the size of the boost would:

- (a) vary by field, being greatest in the heavy-citing fields of the natural sciences and medicine, and least in fields where reference lists are customarily more parsimonious and
- (b) vary somewhat with time and to be especially prominent in fast-moving fields, and
- (c) vary with the proportion of Open Access

Components of the Open Access Advantage

Finally, the expectation – even early on – was that the OA boost would not be a simple thing, but would be composed of more than one element – rather, a set of contributory factors – an assumption that appears to have been proved right in the light of what has been found. Discussions between interested experimenters ranged around what particular elements might influence the boost most, and how this might affect different fields of scholarly research. Did it matter *when* an article was opened up? Was the citation boost going to be the same whether access was facilitated at (or even before) publication in a journal or 6 or 12 months later? How long would the boost take to reach its maximal effect? Were better articles – those destined to be pathfinders in their field – going to benefit demonstrably more than articles of average importance and influence? What proportion of the literature would remain uncitable regardless of how many people could take a look at it, just as it is when only the subscribing few can see it? How much of the citation advantage is absolute and how much is relative and competitive only to decrease as the proportion of the literature that is Open Access increases? These sorts of questions were being turned over in informal exchanges as experiments to test the OA boost hypothesis were begun, and have proved substantially to be prescient.

The possible components of the OA Advantage seemed likely to be:

- (a) A **General OA Advantage**: the advantage that comes from citable articles becoming available to audiences that had not had access to them before, and who would find them citable
- (b) An **Early Advantage**: the earlier an article is put before its worldwide potential audience may affect subsequent citation patterns
- (c) A **Selection Bias**: authors make their better articles Open Access more readily than their poorer articles

(d) A **Quality Advantage**: better articles gain more from the General OA Advantage because they are by definition more citable than poorer articles

Some of the studies listed in this report have attempted to tease out which of these components is at work and where that has been done the main findings have been noted in the final column. Clearly, there is more work ahead in unpacking these factors, but the evidence accumulated so far is informative and is beginning to help us understand much more about what Open Access offers and how it works.

Methodological issues

In methodological terms, studies of the effect of OA on citation impact face some challenges. Variation in the progress and growth of OA means that collecting samples of the critical size needed might be difficult in some fields. Designing a study to ensure the comparing of like with like and developing suitable ways of controlling for correlated and confounding variables is also far from simple. Determining the appropriate time after publication to measure citation differentials needs to take account of citing practices in each discipline or field. An article's publication date is clear, but the date on which it is made OA is not always known. Citation counts can be derived from a number of different sources and each of these produces slightly different figures. Moreover, matching published articles and their OA counterparts can be somewhat problematic if changes have been made during proofing, such as minor adjustments of title or changes in the order of authors.

In all, there are a number of tricky issues that require careful attention at the experimental design stage. Many of the existing studies have not overcome the difficulties entirely satisfactorily. Readers who wish to critically examine the studies listed below are encouraged to read the methodologies very carefully to enable proper appraisal of each study.

The studies

The studies to date are listed below, along with brief notes on their methodologies and results.

Study	Disciplinary area	Sample	Basic analytical approach	Filtered out self-citations?	Citation advantage?	Attribution of advantage to a particular OA component?
<p>Lawrence S (2001) Free online availability substantially increases a paper's impact. <i>Nature</i>, 31 May 2001 http://www.nature.com/nature/debates/e-access/Articles/lawrence.html</p>	Computer science and related areas	119,924 peer-reviewed conference articles	Plotted citation counts against free online availability of papers and showed that freely-available articles are more likely to have high numbers of citations. Time elapsed for citations to accrue: 1-11 years	Yes	Yes. The mean increase in citations to OA articles was found to be 157%. For 'top' publication venues (conferences) the median increase was 284%.	Not examined
<p>Harnad S and Brody T (2004) Comparing the impact of open access (OA) vs non-OA articles in the same journals. <i>D-Lib Magazine</i> 10(6), June http://www.dlib.org/dlib/june04/harnad/06harnad.html (reporting results from this study: http://opcit.eprints.org/feb19oa/brrody-impact.pdf)</p>	Physics	95,012 journal articles and conference papers in publication venues indexed by Web of Science	Compared articles in physics fields that are openly-available in arXiv with those in the same issues of the same journals that are not Open Access. Time elapsed for citations to accrue:2-12 years	Yes	Yes, from 250% to 580% increase.	Not examined
<p>Kurtz MJ, Eichhorn G, Accomazzi A, Grant CS, Demleitner M, Murray SS. (2004) The Effect of Use and Access on Citations. <i>Information Processing and Management</i> 41 (6), 1395-1402. http://www.cfa.harvard.edu/~kurtz/IPM-abstract.html</p>	Astronomy	2592 articles	Used citations from articles in the seven core astrophysics journals to other articles in those journals. Compared citations to articles published in the journals only with citations to articles published in those journals but also posted to the arXiv (the astro-ph section). Time elapsed for citations to accrue: tracked citations from publication over 20 years	No	Yes. Confirmed the Selection Bias and the Early Advantage. Found no general OA Advantage but explained this by saying that all astronomy researchers have access to all the astronomy literature anyway	Yes, explored (and confirmed) Selection Bias and Early Advantage
<p>Antelman K (2004) Do Open-Access Articles Have a Greater</p>	Mathematics, Electrical	610 articles	Compared citations after 2-3 years to articles in ten leading	Yes	Yes. Increases in citations were: Mathematics: 91%	Not examined

Research Impact? <i>College and Research Libraries</i> , 65 (5) 372-382, September 2004 http://eprints.rclis.org/archive/00002309/	engineering, Political science, Philosophy	506 articles 299 articles 602 articles	journals in each discipline with citations to articles from those journals that were freely-available on the Web. Time elapsed for citations to accrue: 2+ years		Electrical engineering: 51% Political science: 86% Philosophy: 45%	
McVeigh ME (2004) Open Access Journals in the ISI Citation Databases: Analysis of Impact Factors and Citation Patterns . Thomson Scientific, October 2004 http://science.thomsonreuters.com/m/pdfs/openaccesscitations2.pdf	All natural sciences	239 journals indexed by Web of Science	Compared OA and non-OA journals (not at individual article level). Looked at citations, impact factor and immediacy index. Time elapsed for citations to accrue: 2 years (basing approach on the Journal Citation Index methodology for calculating Journal Impact factor)	No	Yes, in physics, engineering, mathematics and medicine. Not in chemistry or life sciences. Found that 'recent articles [in OA journals] receive a higher percentage of the total citations than recent articles in traditional [subscription access] journals'.	Not examined
Schwarz G and Kennicutt Jr, RC (2004) Demographic and Citation Trends in Astrophysical Journal Papers and Preprints. <i>Bulletin of the American Astronomical Society</i> , 36 , 1654-1663. http://arxiv.org/abs/astro-ph/0411275	Astronomy	795 articles	Methodology essentially as before, comparing articles published in the <i>Astrophysical Journal</i> only to those published there and made available on arXiv as a preprint. Time elapsed for citations to accrue: 1.5 to 3.5 years	No	Yes, deposit n arXiv's astro-ph increases citations twofold. The difference is slightly higher when the article is posted in arXiv at the time of submission to a journal than when posted after peer review.	No, but results suggest some evidence for the Early Advantage
Metcalfe TS (2005) The Rise and Citation Impact of astro-ph in Major Journals. <i>Bulletin of the American Astronomical Society</i> 37 (2). http://arxiv.org/abs/astro-ph/0503519	Astronomy	Around 7000 articles from 13 major astronomy journals	Compared citations to articles in 13 astrophysics journals with citations to articles in those journals that had also been made OA by posting in the arXiv. Time elapsed for citations to accrue: tracked citations from publication over 12 years	No	Yes, a two-fold difference. And article from higher-impact journals get a proportionately higher boost from being made Open Access by being posted to the arXiv. Higher-impact journal articles not posted to arXiv are cited less often than those from lower-impact journals posted to arXiv.	Not examined

<p>Sahu DK, Gogtay NJ and Bavdekar SB (2005) Effect of open access on citation rates for a small biomedical journal <i>Fifth International Congress on Peer Review and Biomedical Publication</i>, Chicago, September 16-18, 2005. http://openmed.nic.in/1174/</p>	<p>Medicine</p>	<p>One journal (the <i>Journal of Postgraduate Medicine</i>)</p>	<p>Measured citations per volume per year and per 100 articles per year, before and after the journal went Open Access. Time elapsed for citations to accrue: from publication for 15 years</p>	<p>No</p>	<p>Yes, between 3 times and 4.5 times.</p>	<p>Not examined</p>
<p>Hajjem C, Harnad S and Gingras Y (2005) Ten-Year Cross-Disciplinary Comparison of the Growth of Open Access and How it Increases Research Citation Impact. <i>IEEE Data Engineering Bulletin</i>, 28 (4), December 2005. http://eprints.ecs.soton.ac.uk/11688/</p>	<p>Ten disciplines: biology, psychology, sociology, health, political science, economics, education, law, business, management</p>	<p>1,307,038 articles</p>	<p>Robot trawled the Web looking for freely-available articles and, when found, matched them with articles from the same issue of the same journal (using the Web of Science database) that were only available in the subscription journal. Time elapsed for citations to accrue: 6 months to 12 years</p>	<p>Yes</p>	<p>Yes, Open Access produces a citation increase between 36% and 172%</p>	<p>Not examined</p>
<p>Davis PM and Fromerth MJ (2006) Does the arXiv lead to higher citations and reduced publisher downloads for mathematics articles? <i>Scientometrics</i>, 71 (2) May 2007 http://arxiv.org/abs/cs/0603056</p>	<p>Mathematics</p>	<p>2765 articles in 4 journals</p>	<p>Compared citations to articles in the journals with citations to articles published in those journals but also posted to arXiv. Time elapsed for citations to accrue: 6 months to 8 years</p>		<p>Yes. Mean increase is 35% (number of citations to each article increased from between 0.8 to 2.1, giving a mean increase of 1.1, corresponding to a 35% increase overall)</p>	<p>Explored Early Advantage and Quality Advantage. The results suggest that the “OA effect may be severely limited to highly-cited articles” i.e. the best articles get the greatest citation benefit. This confirms the Quality Advantage but there is no empirical evidence that this Quality Advantage effect is also a Selective Bias effect (that is, that authors are</p>

<p>Eysenbach G (2006) Citation Advantage of Open Access Articles <i>PLoS Biology</i>, 4 (5), May 2006 http://www.plosbiology.org/article/info:doi/10.1371/journal.pbio.0040157</p>	<p>Natural sciences</p>	<p>1492 articles in <i>PNAS</i>, 212 of which were paid-for Open Access</p>	<p>Compared citations to OA and non-OA articles published in <i>PNAS</i> over a period of 6 months. Time elapsed for citations to accrue: 18 months</p>	<p>No</p>	<p>Yes. OA articles are 2.1 times more likely to be cited in the first 4-10 months after publication and 2.9 times as likely to be cited 10-16 months after publication</p>	<p>selectively making their best articles OA) The study found no evidence for Early Advantage</p> <p>Not examined specifically</p>
<p>Henneken EA, Kurtz MJ, Eichhorn G, Accomazzi A, Grant C, Thompson D, and Murray SS (2006) Effect of E-printing on Citation Rates in Astronomy and Physics <i>Journal of Electronic Publishing</i>, Vol. 9, No. 2, Summer 2006: http://quod.lib.umich.edu/cgi/t/text/text-idx?c=jep;view=text;rgn=main;idno=3336451.0009.202 and http://arxiv.org/abs/cs/0604061</p>	<p>Astronomy and physics</p>	<p>All articles published in 2 astronomy and 2 physics journals</p>	<p>Tracked citations to these articles over 20 years, covering the periods before and after the arXiv was established. Time elapsed for citations to accrue: from publication over 20 years</p>	<p>No</p>	<p>Yes. On average, articles posted on arXiv were 'cited more than twice as often as those published only in the journals. The study also found that articles in arXiv are read more and cited more</p>	<p>The authors suggest that the results support their suggestion from previous studies that in physics the best articles are made OA earliest, giving them a significant citation advantage</p>
<p>Metcalfe TS (2006) The Citation Impact of Digital Preprint Archives for Solar Physics Papers. <i>Solar Physics</i>, 239 (1-2), December 2006, 549-553: http://arxiv.org/abs/astro-ph/0607079</p>	<p>Solar physics</p>	<p>171 articles in the test set and 170 articles in the control set (the control set consists of articles in peer-reviewed conference proceedings</p>	<p>Compared OA to non-OA articles. OA articles were made OA either in the arXiv or in Montana State University's solar physics Open Access archive. Time elapsed for citations to accrue: 2+ years</p>	<p>No</p>	<p>Yes. Articles posted to MSU's archive gained 1.7 times as many citations as non-OA articles and those posted to arXiv received 2.6 times as many citations</p>	<p>No evidence for Selection Bias. Similar citation boost for conference papers as for journal articles, "suggesting that the higher citation rates are not the result of self-selection of above average papers" [since conference papers are of variable quality]</p>

<p>Zhang Y (2006) The Effect of Open Access on Citation Impact: A Comparison Study Based on Web Citation Analysis. <i>Libri</i>, 56 (3), September 2006, 133-199. http://librijournal.org/pdf/2006-3pp145-156.pdf</p>	<p>Communication studies (IT)</p>	<p>Two journals, one OA and one not</p>	<p>Compared citations for articles in the two journals. Retrieved 'web citations' using Google and Yahoo! Time elapsed for citations to accrue: 4-5 years</p>	<p>No</p>	<p>Yes, on average Open Access articles received twice the citations of those that are non-OA. The study also identified that the biggest increase in citations came from 'non-authoritative documents' (the other two categories were scholarly documents and teaching documents). This category includes more popular literature and professional and practitioner community publications, emphasising the reach of OA and the impact it brings to those constituencies. The study also found a citation boost from authors in developing countries</p>	<p>Not examined</p>
<p>Moed HF (2006) The effect of 'Open Access' upon citation impact: An analysis of ArXiv's Condensed Matter Section. <i>Journal of the American Society for Information Science and Technology</i>, Vol. 58, No. 13, 2007, 2145-2156. http://arxiv.org/abs/cs.DL/0611060</p>	<p>Condensed matter physics</p>	<p>74,521 articles</p>	<p>Compared citations to articles posted to arXiv with those to articles in the same journals that were not made available through arXiv Time elapsed for citations to accrue: 12 months to 14 years</p>	<p>Yes</p>	<p>The study was not designed specifically to explore whether OA brings extra citation impact but to test the effects of 'general Open Access' versus Early Access versus Selection Bias.</p>	<p>Confirmed the Early Access effect and Selection Bias, but found no 'general OA' effect. Concluded that OA accelerates citations by making articles available earlier rather than by making them freely available</p>

<p>Piwowar HA, Day RS and Fridsma DB (2007) Sharing Detailed Research Data Is Associated with Increased Citation Rate. <i>PLoS ONE</i>, March 21, 2007. http://www.plosone.org/article/ftchArticle.action?articleURI=info:doi/10.1371/journal.pone.0000308</p>	Clinical trials	Journal articles describing 85 microarray trials	Looked at the availability of Open Data supporting the articles to see if this correlated with citation impact. Time elapsed for citations to accrue: 4 to 7 years	No	Publicly-available datasets (open data) are significantly associated with a 69% increase in citations to articles that the data accompany. This correlation is independent of Journal Impact Factor, country of authors and time since publication	Not examined
<p>Tonta Y, Ünal Y and A, U (2007) The Research Impact of Open Access Journal Articles <i>Proceedings ELPUB 2007, the 11th International Conference on Electronic Publishing</i>, Vienna, 13-15 June 2007 http://eprints.rclis.org/9619/</p>	Biology, economics, physics, mathematics, chemical engineering, environmental science, sociology, psychology, anthropology	270 articles (30 from each discipline)	Looked at citations to articles randomly picked from journals listed in the Directory of Open Access Journals. Time elapsed for citations to accrue: 4 to 8 years	No	Not measured directly. The study examined whether there is a relationship between OA citation impact and the characteristics of the subject field: that is, is there an OA citation difference between 'hard, urban' subjects and 'soft, rural' ones. The answer was, not entirely conclusively, no	Not examined
<p>Lin SK (2007) Editorial: Non-Open Access and Its Adverse Impact on <i>Molecules</i> <i>Molecules</i>, 12, 1436-1437, 16 July 2007. http://www.mdpi.org/molecules/html/12071436.htm</p>	Molecular science	Two journals, <i>Molecules</i> and <i>International Journal of Molecular Science</i> , both published by MDPI (Molecular Diversity Preservation International)	Looked at papers published in 2005 and 2006 under the 'hybrid OA' scheme that these journals had at the time. Time elapsed for citations to accrue: 12 to 24 months	No	Yes. In that period, the number of OA articles in the journals declined and the journals' Impact Factor reduced concomitantly. As a result, the publisher has made all articles in these journals Open Access and expects the Journal Impact factors for rise accordingly (see Lin, 2009 for follow-up study)	Not examined

<p>Sotudeh H and Horri A (2007) The citation performance of open access journals: A disciplinary investigation of citation distribution models <i>Journal of the American Society for Information Science and Technology</i>, 58 (13), 2145-2156.</p>	<p>Various scientific disciplines</p>	<p>'Prestigious, pure, stable and long-lasting Open Access journals' [authors' descriptions]</p>	<p>Unclear</p>	<p>Unknown</p>	<p>Unknown. Only the abstract is available except to subscribers to the journal, and the main results and conclusions are not described in the abstract</p>	<p>Unknown</p>
<p>Kurtz MJ and Henneken EA (2007) Open Access does not increase citations for research articles from The Astrophysical Journal http://arxiv.org/abs/0709.0896</p>	<p>Astronomy</p>	<p>4271 articles published in the <i>Astrophysical Journal</i>, which was Open Access but then became subscription-access in 1998</p>	<p>Compared citations to articles published in the <i>Astrophysical Journal</i> prior to and after 1 January 1998, when the journal switched from Open Access to toll-access. These articles were matched with counterparts that had also been made Open Access by posting in arXiv. Time elapsed for citations to accrue: 9 to 10 years</p>	<p>No</p>	<p>Yes. Found that posting in arXiv raised citations two-fold but citations to articles in the journal before and after it switched to subscription access did not change. These authors have previously pointed out that all astronomy researchers have access to all astronomy journals anyway, meaning that the kind of access they have (Open or subscription) makes no difference.</p>	<p>Posting in arXiv brings a twofold increase in citations, and this is likely to be the Early Access effect</p>
<p>Cheng WH and Ren SL (2008) Evolution of open access publishing in Chinese scientific journals <i>Learned Publishing</i>, 21 (2) 140-152 http://www.ingentaconnect.com/content/alpsp/lp/2008/00000021/0000002/art00009</p>	<p>Medicine, biology, agricultural sciences, chemistry and a set of university-produced journals</p>	<p>240 Chinese Open Access journals indexed in the Chinese Science & Technology Journal Citation Index. The sample contained 91 fully OA journals and 139 hybrid OA journals</p>	<p>Examined citations, immediacy index and Journal Impact Factor for OA journals and non-OA journals in the 4 fields and in the set of university-produced journals. Time elapsed for citations to accrue: 2 years (basing approach on the Journal Citation Index methodology for calculating Journal Impact factor)</p>	<p>No</p>	<p>Yes, there was an approximately two-fold increase in citations for OA journals</p>	<p>Not examined</p>

<p>Norris M, Oppenheim C and Rowland F (2008) Open Access Citation Rates and Developing Countries <i>12th International Conference on Electronic Publishing (EIPub 2008)</i>, Toronto, June 25-27, 2008. http://elpub.scix.net/cgi-bin/works/Show?id=335_elpub2008</p>	Mathematics	1158 articles from 16 high-impact journals	Used mathematics because it is not covered by any special access schemes for developing countries (e.g. HINARI). Tested the hypothesis that authors in developing countries are the main (or a significant) cause of the Open Access Advantage. Found OA articles via Google and matched them with non-OA counterparts in the same journals. Time elapsed for citations to accrue: 2 to 4 years	No	Yes. The study found a “modest difference” in citations to the two groups of articles that came from authors in the developed world (average 3.84 citations to OA articles versus 2.92 to non-OA articles), but a much greater difference for authors from developing countries. The authors of this article state that the sample of authors from developing countries was small and the study needs to be repeated with a larger sample.	Not examined
<p>Norris M, Oppenheim C, and Rowland F (2008) The citation advantage of open-access articles <i>Journal of the American Society for Information Science and Technology</i>, 59 (12), 2008, 1963-1972 http://hdl.handle.net/2134/4083</p>	Ecology, applied mathematics, sociology, economics	4633 articles	Compared citations to OA and non-OA articles in these disciplines, using articles published in the same journal. Time elapsed for citations to accrue: 2 to 4 years	No	Yes. The mean citation count for OA articles was 9.04 and for non-OA articles it was 5.76	Not examined
<p>Davis PM, Lewenstein BV, Simon DH, Booth JG and Connolly MJL (2008) Open access publishing, article downloads, and citations: randomised controlled trial <i>BMJ</i>, 2008;337:a568 http://www.bmj.com/cgi/content/abstract/337/jul31_1/a568</p>	Physiology	1619 articles (247 OA and 1372 non-OA)	Made a set of articles in 4 issues of 11 American Physiological Society journals OA (randomly picked) and left the rest non-OA. All these journals routinely make all their contents OA after 12 months. Time elapsed for citations to accrue: 12 months	No	No. Found that ‘full-text’ downloads increased by 89% with Open Access and ‘PDF’ downloads increased by 42%, but that OA reduced citations by 5%.	Not examined

<p>Frandsen TF (2008) The integration of open access journals in the scholarly communication system: Three science fields. <i>Information Processing & Management</i>, 45 (1), January 2009, 131-141. http://www.hprints.org/hprints-00326285/en/</p>	<p>Biology, mathematics, pharmacy & pharmacology</p>	<p>74 biology journals, 25 mathematics journals, 20 pharmacy & pharmacology journals</p>	<p>Compared citations from subscription journals to journals that are OA and those that are non-OA. Controlled for self-citation, Journal Impact Factor and sampling dependency. Time elapsed for citations to accrue: 2 years (basing approach on the Journal Citation Index methodology for calculating Journal Impact factor)</p>	<p>Yes</p>	<p>No. The effect of OA on citations was neutral in biology and mathematics and negative in pharmacy & pharmacology</p>	<p>Not examined</p>
<p>Gaule P and Maystre N (2008) Getting cited: does open access help? <i>Ecole Polytechnique Fédérale de Lausanne, CEMI-WORKINGPAPER-2008-007</i>, November 2008 and http://ideas.repec.org/p/cmi/wpaper/cemi-workingpaper-2008-007.html</p>	<p>Biology</p>	<p>4388 articles published in <i>PNAS</i> over 2 years</p>	<p>Compared citations accumulating over time for articles in the journal that had been made OA as a result of authors paying an article-processing fee with those that were not OA. Also looked to see if there was a correlation with article quality by looking at articles that were in the Faculty of 1000 (F1000) dataset. Time elapsed for citations to accrue: from publication over 2 years</p>	<p>No</p>	<p>Yes, but the difference was not found to be statistically significant. [Note that <i>PNAS</i> makes its contents open to all at 6 months and to readers in developing countries from the time of publication]</p>	<p>Selection Bias explains at least a part of the observed OA citation impact</p>
<p>Norris M (2009) The citation advantage of open access articles. PhD thesis, Loughborough University http://hdl.handle.net/2134/4089</p>	<p>Ecology, mathematics, sociology and economics</p>	<p>In Round 1, 4633 articles: in Round 2, 82 economy journals, 21 sociology journals</p>	<p>Compared citations to articles in these journals with those also made OA. Identified OA articles by using Google and OAlster. Time elapsed for citations to accrue: 2 to 4 years</p>	<p>No</p>	<p>Yes. The mean citation count for OA articles was 9.04 and for non-OA articles 5.76 (see Norris et al 2008). The size of the advantage varied with discipline; sociology showed the greatest OA advantage and ecology the lowest. Correlation with author number and Journal Impact Factor is weak or non-existent</p>	<p>Not examined</p>

<p>Evans JA and Reimer J (2009) Open Access and Global Participation in Science <i>Science</i>, 323 (5917), 20 February 2009, 1025</p>	All	26 million articles in 8000 journals	Compared citations to OA or non-OA journals (not articles)	No	Yes. The increase in citations with OA is 8% for newly-published articles, and twice as large for citations coming from developing countries. The study also found a jump in citations when articles first become openly available from commercial publishers at the end of an embargo period	Not examined
<p>Gargouri Y and Harnad S (2009) Logistic regression of potential explanatory variables on citation counts. Preprint 11/04/2009 http://www.crsc.uqam.ca/yassine/SelfArchiving/LogisticRegression.htm</p>	Engineering, Biology, biomedicine, chemistry, psychology, mathematics, clinical medicine, health, physics, social sciences, earth sciences	27,197 articles in total. 6,215 articles from institutions with mandatory OA policies and 20,982 control articles from institutions without such policies (i.e. articles voluntarily made OA by their authors)	Compared these OA articles to articles published in the same issue of the same journals that had not been made OA. Analysed by logistic regression. Time elapsed for citations to accrue: 2 to 6 years	Yes	Yes, and size of OA advantage varies with discipline. There was no correlation found with mandated or non-mandated status. The advantage found was independent of Journal Impact Factor, time since publication, number of references in the article and number of co-authors. Found that the increase in citations for OA articles is strong for highly-cited articles. Articles from mandated institutions have increased citations in the medium-to-highly cited range. Review articles have increased citations and the effect is greatest in the highly-cited range.	Confirms other findings that suggest that the best quality (i.e. the most highly-cited) articles have most to gain, relatively, from OA. Also found no evidence to support the Selection Bias, since there was no difference in the citation advantage for mandated articles and non-mandated articles (i.e. that might be preferentially made OA out of choice because their authors thought they were better examples of their work)
<p>Frandsen TF (2009) The effects of open access on unpublished documents: A case study of economics working papers. <i>Journal of Informetrics</i> (2009) 3 (2), 124-133 http://www.hprints.org/hprints-</p>	Economics	Working papers in EconLit, RePEc and ten institutional working paper collections	Time elapsed for citations to accrue: Citations to working papers were measured over a period of ten years. Time elapsed for citations to accrue: up to 10 years	No	No. Found no clear tendency towards an increase in impact during 10 years of open availability for the working papers. Conversely, economics articles in high-impact journals do show a clear tendency for	Not examined

citation impact to increase in a ten-year period. The author therefore deduced that there is no OA citation advantage

<p>Bernius S and Hanauske M (2009) Open Access to Scientific Literature - Increasing Citations as an Incentive for Authors to Make Their Publications Freely Accessible. <i>42nd Hawaii International Conference on System Sciences (HICSS '09)</i>, 5-8 Jan. 2009, pp. 1-9 http://www.is-frankfurt.de/publikationenNeu/Op enAccesstoScientificLiteratu3032.pdf</p>	<p>Not an observational study</p>	<p>Not an observational study</p>	<p>The authors developed a computer simulation of citation networks, using a range of assumptions for parameters, to model citing behaviour and outcomes. The methodology attempted to account for causation as well as model effect.</p>	<p>Not applicable</p>	<p>Yes</p>	<p>Did not model Early Advantage: all modelling was on access from the moment of publication. Did not model Selection Bias specifically, either. The methodology randomly modelled high-impact and low-impact authors switching their strategy to making their articles Open Access: no Selection Bias signal was detected</p>
<p>Lin S-K (2009) Full Open Access Journals Have Increased Impact Factors (editorial). <i>Molecules</i>, 2009, 14(6) 2254-2255 http://www.mdpi.com/1420-3049/14/6/2254/</p>	<p>Molecular science</p>	<p>Two journals, <i>Molecules</i> and <i>International Journal of Molecular Science</i>, both published by MDPI (Molecular Diversity Preservation International)</p>	<p>Looked at the Journal Impact factors after the journals had gone fully OA. Also looked at two other journals from the same publisher, one that experimented briefly with paid-for OA (via article-processing charges) and one that made all its content OA a short time before the experiment. Time elapsed for citations to accrue: 2 years (basing approach on the Journal Citation Index methodology for calculating Journal Impact factor)</p>	<p>No</p>	<p>Yes. Reported an increase in Journal Impact Factors after the journals were made fully-OA. All MDPI journals are now fully Open Access</p>	<p>Not examined</p>

<p>Lansingh VC and Carter MJ (2009) Does Open Access in Ophthalmology Affect How Articles are Subsequently Cited in Research? <i>Ophthalmology</i>, 116(8) 1425-1431</p>	<p>Ophthalmology</p>	<p>480 OA articles and 415 non-OA control articles, all published in ophthalmology journals</p>	<p>Compared citations to articles that were made OA by their authors with those to articles that were not OA in the same set of journals.</p>	<p>No</p>	<p>No. Found an increase in mean citations from 11.5 to 15.2 but the advantage correlated with author number, country of publication, language, subject area and funding though not with access</p>	<p>Not examined</p>
<p>Gentil-Beccot, A, Mele S, Brooks T (2009) Citing and Reading Behaviours in High-Energy Physics. How a Community Stopped Worrying about Journals and Learned to Love Repositories http://arxiv.org/abs/0906.5418</p>	<p>High energy physics</p>	<p>286,180 OA articles in three mutually-exclusive sets, all compared with articles in subscription journals</p>	<p>Compared citations to three sets of articles made OA with citations to articles published in the same journals but not made OA. The sets were: preprints (pre-peer-review) posted in arXiv and subsequently published in journals; postprints posted in arXiv and subsequently published in journals; articles posted in arXiv and never published in journals. Time elapsed for citations to accrue: from publication over 2 years</p>	<p>No</p>	<p>Yes. Found an “immense” [5-fold] citation advantage from Open Access. Also found that 15% of articles have accumulated citations by the time of publication if they are posted to arXiv as preprints. Finally, found that articles made OA in hybrid high energy physics journals had no citation advantage</p>	<p>Yes, found evidence for the Early Advantage</p>
<p>Kousha K and Abdoli M (2009) The citation impact of Open Access Agricultural Research: a comparison between OA and Non-OA publications. <i>World Library And Information Congress: 75th IFLA General Conference and Council</i>, 23-27 August 2009, Milan, Italy http://www.ifla.org/files/hq/papers/ifla75/101-kousha-en.pdf</p>	<p>Agricultural sciences</p>	<p>400 articles published in journals indexed by Web of Science plus 100 OA articles and 100 non-OA articles from journals published by the FAO</p>	<p>Compared citations to 400 articles in journals that had also been made OA (identified by using Google and Google Scholar) with those to articles published in those journals only. Time elapsed for citations to accrue: 2 years (basing approach on the Journal Citation Index methodology for calculating Journal Impact factor)</p>	<p>No</p>	<p>Yes. Mean citation counts found: 2 for articles published in journals indexed by Web of Science; 4 for articles published in those journals but also made OA. The FAO journal set showed a mean citation rate for OA of 1.74 citations per article versus 0.28 citations for non-OA articles. Concluded that OA is advantageous to individual articles but not to whole journals</p>	<p>Not examined</p>

<p>Gargouri Y, Hajjem C, Lariviere V, Gingras Y, Brody T, Carr L and Harnad S (2010) Self-Selected or Mandated, Open Access Increases Citation Impact for Higher Quality Research. <i>PLoS ONE</i> (Submitted)</p> <p>The study is ongoing and details can be found here: http://www.crsc.uqam.ca/yassine/RegByDiscipline/AnalysisByDiscipline.doc</p>	<p>Engineering, Biology, biomedicine, chemistry, psychology, mathematics, clinical medicine, health, physics, social sciences, earth sciences</p>	<p>27,197 articles in 1984 journals. See Gargouri & Harnad, 2009. This is the updated version of that preprint</p>	<p>See Gargouri & Harnad, 2009. This is the updated version of that preprint. Time elapsed for citations to accrue: 2 to 6 years</p>	<p>Yes</p>	<p>Yes, and size of OA advantage varies with discipline. There was no significant reduction in the OA advantage found with mandated or non-mandated status. The advantage found was independent of Journal Impact Factor, time since publication, number of references in the article and number of co-authors. Found that the increase in citations for OA articles is stronger for highly-cited articles. Articles from mandated institutions have increased citations in the medium-to-highly cited range. Review articles have increased citations and the effect is greatest in the highly-cited range.</p>	<p>Confirms other findings that suggest that the best quality (i.e. the most highly-cited) articles have most to gain, relatively, from OA. Also found no evidence to support the Selection Bias, since there was no difference in the citation advantage for mandated articles and non-mandated articles (i.e. those that might be preferentially made OA out of choice because their authors thought they were better examples of their work)</p>
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Summary data from these studies are provided below.

Measure	Result
Studies finding a positive Open Access citation advantage	27
Studies finding no Open Access citation advantage (or an OA citation disadvantage)	4

Size of OA citation advantage when found (and where explicitly stated by discipline)	% increase in citations with Open Access
Physics/astronomy	170 to 580
Mathematics	35 to 91
Biology	-5 to 36
Electrical engineering	51
Computer science	157
Political science	86
Philosophy	45
Medicine	300 to 450
Communications studies (IT)	200
Agricultural sciences	200 to 600