

RT. A Journal on Research Policy & Evaluation **1** (2017)

Submitted on 16 January 2017, accepted on 26 July 2017, published on 4 August 2017

Doi: 10.13130/2282-5398/7997

How accessibility influences citation counts: The case of citations to the full text articles available from ResearchGate

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Abstract: It is generally believed that the number of citations to an article can positively be correlated to its free online availability. In the present study, we investigated the possible impact of academic social networks on the number of citations. We chose the social web service “ResearchGate” as a case. This website acts both as a social network to connect researchers, and at the same time, as an open access repository to publish post-print version of the accepted manuscripts and final versions of open access articles. We collected the data of 1823 articles published by the authors from four different universities. By analyzing these data, we showed that although different levels of full text availability are observed for the four universities, there is always a significant positive correlation between full text availability and the citation count. Moreover, we showed that both post-print version and publisher’s version (i.e., final published version) of the archived manuscripts receive more citations than non-OA articles, and the difference in the citation counts of post-print manuscripts and publisher’s version articles is nonsignificant.

Keywords: academic social web services; gold open access; green open access; full text; visibility; citation analysis

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1. Introduction

Citation analysis is commonly used as an approach to evaluate quality of research articles and performance of researchers and journals (Eysenbach, 2006; Garfield, 2006a). Most of the scientometric measures of publishing performance, including impact factor and h-index, are based on citation statistics (Garfield, 2006b; Braun et al, 2006). Consequently, it is important to understand how factors other than scientific merit may influence the number of article citations (Moed, 2009; Falagas et al, 2008).

Many studies have previously shown the positive impact of free online availability of articles on their citations (Antelman, 2004; Niyazov et al, 2016). For this reason, it is not surprising that the total number of open access (OA) scholarly journals and the number of research articles published in these journals have increased significantly during the last decade (Kamat, 2015; Laakso et al, 2011). In contrast, some studies showed that there may not be a significant correlation between citation count and free accessibility of articles (Davis, 2008; Craig et al, 2007) and other factors could affect citation counts too. For example, Gaule and Maystre suggested that the higher number of citation of OA articles could be due to self-selecting of higher quality articles to be open-access by authors (Gaule et al, 2011).

Today, in the era of social networking websites, a striking increase in communication and collaboration among scientists has occurred (Wren, 2005; Moed et al, 2016). This new way of scientific communication is now so popular that some scientometric measures, e.g., Altmetrics, are introduced based on the citations and bookmarkings within social web services (Niyazov et al, 2016; Ale Ebrahim et al, 2014; Van Noorden, 2015). There are also a number of academic social network websites designed for people in the field of science and technology, including Academia.edu, Mendeley and ResearchGate. Such web services are primarily developed to help researchers in communicating and sharing scientific texts with other scholars in an efficient way (Ovadia, 2014), although they are also suggested to be used for evaluation purposes (Hoffmann et al, 2016; Min-ChunYu et al, 2016).

ResearchGate, as one of the most popular social networks among academics, currently has over 10 million registered members and has indexed more than 100 million articles. Moreover, ResearchGate also acts as an open access repository and encourages the researchers to archive a post-print version of their manuscripts (following the “green OA” model). Despite the fact that this website asks the members to abide by the laws of copyright, in practice many authors publish the publisher’s version of their works without permission from publisher (Kamat, 2015; Thelwall et al, 2015; Jamali, 2015).

In the present work, we collected the data of 1823 articles published by the authors from four different universities, namely King’s College London, University of Cape Town, Peking University, and University of Tehran. We study whether publishing OA articles or posting manuscripts on ResearchGate depends on the researcher’s academic affiliation. Furthermore, we investigate how being OA or being freely available can influence the number of citations to an article. Among researchers, it sometimes happens that practitioners of a heterodox methodology complain about the (either real or alleged) tyranny of a mainstream school of thought. Whereas some of these quarrels depend on private rivalries, it is almost indisputable that, within many disciplines, there actually are two or more rival schools of thought whose followers periodically engage in disputes and try to ostracize each other. I argue that, as far as these rivalries are genuine (i.e., as far as they are rooted in some genuinely epistemological disagreement), such disputes highlight social phenomena that have important epistemic consequence.

2. Materials and Methods

2.1 Analysis of the papers published by four universities

Based on Alexa ranking, United Kingdom, China and Iran are among the top countries with the highest number of ResearchGate visits.ⁱ South Africa is a developing country in which English is the official scientific language. Therefore, we included this country in our study for comparing its characteristics to the United Kingdom on the one hand, and to Iran and China on the other hand. In our study, we chose one representative university from each country (Table 1). One should keep in mind that based on one single university, it is not possible to draw any general conclusion among the profiles of these countries.

University name	Abbreviation	Country	Number of analyzed documents
King's College London	KCL	United Kingdom	505
University of Cape Town	UCT	South Africa	228
Peking University	PU	China	480
University of Tehran	UT	Iran	610

Table 1. List of selected universities in the present study

In June 2015, the profile of the universities was searched at the ResearchGate website (<https://www.researchgate.net>), and researchers from different research areas were randomly chosen. For the University of Cape Town, we considered all of the authors. Altogether, the publication data of all chosen researchers were obtained, which comprises 1823 articles published from 2012 to 2014. In some cases, we observed an inconsistency between the publication year reported in the journal website and the publication year reported in ResearchGate. In such cases, the date reported in the journal website was considered as correct.

For each article, the following data were collected:

- Impact factor of the journal in which the paper is published;
- The number of authors;
- Availability as an OA article via the journal published website;
- Availability of the full text article (as the post-print or publisher's version) via ResearchGate;
- Total citation count based on Google Scholar website (in June 2015)

In the present study, we adopted the following definitions. An article was considered as a gold OA article if its full text is downloadable from the journal website. If an article is not available as gold OA, but its full text is available via ResearchGate, then it is considered as a green OA article (Craig et al, 2007; Harnad et al, 2004). Such a green OA article is either available in ResearchGate as a post-print (that is, the final author's draft after refereeing) or as a publisher's version (the final copy of the peer reviewed edited full text in the journal layout) (Craig et al, 2007). Finally, if the full text article is available neither from the journal website nor from ResearchGate, then it is considered as a non-OA article. It should be mentioned that the full text of gold OA articles are almost always (automatically) available in ResearchGate. Additionally, our definition of green OA might be an underestimation of

the real definition, as full texts might be available from other websites and repositories (e.g., ArXiv), but not ResearchGate.

2.2. Statistical Analysis

In the present work, the data were generally not normally distributed and most of the variables were integer-valued. Therefore, for comparing two distributions, we used Wilcoxon rank-sum test. To determine whether there is a significant difference between two observed frequencies in two categories, we used chi-squared test.

3. Results

Figure 1 shows the number of articles whose full texts are available in ResearchGate (i.e., the circles) and other articles (i.e., the non-OA articles). Note that the articles which are available as OA in the journal website were also available from the ResearchGate. Additionally note that in the present work, the term “green OA” refers to the articles whose full texts are freely available via ResearchGate (but not the journal website).

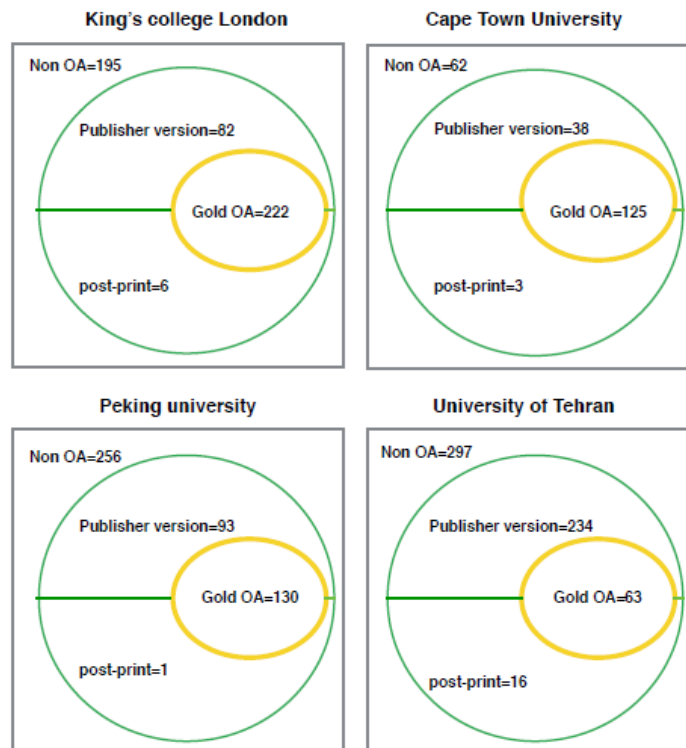


Figure 1. Venn diagram representing the number of OA and non-OA articles published by the four universities. In each panel, the circle represents the articles which are available as full

text in ResearchGate, either as gold OA articles (i.e., the internal, strong-yellow circle) or green OA articles (i.e., the big, green circle). The green OA articles are either archived in the post-print format or publisher's version format. Those articles whose full texts are not available in ResearchGate are counted as non-OA.

3.1. Increased citation count is linked to online availability of the article

In the first part of our analysis, we investigated if the number of citations to gold OA articles is significantly greater than the number of citations to non-OA ones. A significant difference was found between these two variables ($p=2.5 \times 10^{-9}$ in Wilcoxon test; OA mean rank=752 \pm 591.8; Non OA mean rank=624.09 \pm 483.3; SI Table 1) which confirms that gold OA articles attract more citations compared to non-OA articles.

Full text version of gold OA articles are almost always available in ResearchGate. However, we also tested whether availability of green OA full text articles (in both post-print and publisher's version formats) influences the number of citations. The difference between the citation count to green OA articles and the citation count of non-OA articles was significant ($p=1.1 \times 10^{-8}$ in Wilcoxon test; Green OA mean rank=710.95 \pm 577.02 Non OA mean rank=601.74 \pm 440.94; SI Table 2). Such a significant difference was also present if this analysis was independently repeated for each of the four universities (data not shown).

We observed that the authors of non-OA articles may publish their works as post-prints or publisher's versions. Many journals allow online archiving of the manuscript in post-print form to make it a green OA article. In contrast, archiving publisher's version of papers is often not allowed.

We compared the number of citations to post-print and publisher's version articles. No significant difference was observed between the medians of the two distributions ($p=0.12$ in Wilcoxon test; Post print mean rank=170.7 \pm 260.4 publisher's version mean rank=240.8 \pm 62.8; SI Table 3), which means that it is not possible to conclude that publisher's version of articles attract more citations compared to the post-print versions. It should be mentioned that because of the low count of the post-print articles and consequently low power of this test, these results are only preliminary results. Therefore a more comprehensive study is required to obtain conclusive results.

3.2. Factors which influence full text availability of non-OA articles

In the next step we studied the factors which can influence full text availability of non-gold OA articles. One important parameter is impact factor of the journal. Briefly, there was conjecture that one motivation to archive and distribute the full text of an article on ResearchGate might be to communicate low-quality articles with other researchers with the hope to attract more attention. On the other hand, researchers may simply want to proudly share their high-quality findings with others. To test which of the above scenarios might be stronger, the difference between impact factor (IF) of Green OA and Non OA articles was explored. No significant difference was observed between the two variables ($p=0.079$ in Wilcoxon test; Green OA IF mean rank:665.73 \pm 577.02; Non OA IF mean rank=628.14 \pm 440.94; SI Table 4), suggesting that impact factor, in general, is not a major determinant of full text archiving and availability. A similar analysis was performed for each of the universities, and interestingly, only in case of UT and PU a significant difference between impact factor of Green OA and NonOA articles observed(For PU: $p=0.03$ in Wilcoxon test; Green OA IF mean

rank:201.52±169.6; Non OA IF mean rank=165.95±102.77) and (For UT: $p=0.0001$ in Wilcoxon test; Green OA IF mean rank= 295.40±228.26; Non OA IF mean rank=255.98±209.42; SI Table 5).

It has been previously suggested that there is a positive correlation between number of authors of an article and its citation count (Borsuk, 2009). In this study we showed that green OA articles may attract more citations than non-OA articles. Here, we tested the difference between the number of authors of green OA and non-OA articles to see if such significant difference in the number of authors of green OA vs. non-OA articles exists. A significant difference was observed in this case ($p=1.4\times 10^{-5}$ in Wilcoxon test; Number of authors for Green OA mean rank=700.11±577.02; Number of authors for Non OA mean rank=608.06±440.94; SI Table 6).

3.3. Pairwise comparison of the four universities

Nowadays, different ranking of universities are published every year. Some of these university ranking systems include citation-dependent measures, e.g. *h*-index, in their analysis. Here, as a side result, we show that citations to the papers published from a certain university might be linked with the OA-related policies of that university/country, and the scientific merit of the papers is not the only determinant of the citation count of each university. Note that due to the small sample size (i.e., only four universities) and the nature of our analysis (which are to detect correlations and not causes), one cannot extend the findings of the present analysis to draw explicit conclusions on OA rate for each institution or their OA advantage.

The gold OA publication rate seems to be considerably different among the four universities (44% in KCL, 55% in UCT, 27% in PU and 10% in UT). In this step, we compared each pair of universities to see if OA publication rate is significantly different over these universities. The results are summarized in Table 2. Interestingly, all of the pairwise differences were found to be significant.

University pair	Chi-square p -value	Test Statistic
KCL vs. UCT	6×10^{-3}	7.01
KCL vs. PU	3×10^{-8}	29.80
KCL vs. UT	1×10^{-37}	162.48
UCT vs. PU	7×10^{-13}	50.42
UCT vs. UT	6×10^{-43}	186.29
PU vs. UT	6×10^{-13}	50.61

Table 2. Comparing universities for their OA publication rate. In each case, a 2×2 contingency table was constructed to summarize the number of OA vs. non-OA articles which are published by University X vs. University Y. Then, the significance was computed as the chi-square p -value.

The archiving rate was also found to be comparable over the universities except for the case of UT (17% in KCL, 18% in UCT, 20% in PU and 41% in UT). In the next step, we repeated a similar analysis to compare the archiving rate of the non-gold OA articles. The results of this analysis are shown in Table 3.

University pair	Chi-square p -value	Test Statistic
KCL vs. UCT	0.13 [†]	2.198
KCL vs. PU	0.27 [†]	1.173
KCL vs. UT	6×10^{-5}	15.889
UCT vs. PU	1×10^{-2}	5.774
UCT vs. UT	0.32 [†]	0.992
PU vs. UT	2×10^{-8}	30.273

[†] Nonsignificant at the level of 0.05.

Table 3. Comparing universities for archiving rate of their non-gold OA articles. In each case, a 2×2 contingency table was constructed to summarize the number of archived vs. not-archived articles which are published by University X vs. University Y. Then, the significance was computed as the chi-square p -value.

4. Discussion

4.1. Free full text availability is correlated with increased citation rate

It is suggested that free online availability of an article increases its citation potential (Eysenbach, 2006). In the present study, we showed that a similar pattern is observed for the dataset of articles selected from ResearchGate. Moreover, some other studies had shown that archiving a manuscript can increase its citation potential (Kurtz et al, 2005; Davis et al, 2007). Here, we show that full text availability via ResearchGate has a similar positive effect. This finding can be explained by the fact that the full text articles are not only available to ResearchGate members, but also accessible to others via Google or Google Scholar (Jamali et al, 2015). It should be mentioned that in the present article we only considered those OA articles whose full text version is available from the journal website or from ResearchGate. In fact, the significant difference that was observed between the citation counts of OA and non-OA articles might be even stronger, as many articles which are counted as non-OA here might be in fact available via other platforms (like ArXiv). Therefore, such articles might attract higher number of citations due to their actual OA availability.

As mentioned above, archiving manuscripts can increase the citation potential of the article. We showed that such an increase is comparable in case of post-print and publisher’s version of the article. Therefore, it is reasonable for the traditional non-gold OA publishers to encourage researchers to archive their works in post-print format, as such availability can increase the citation rates, and eventually, the journal impact factor.

4.2. The relationship between archiving non-gold OA articles and impact factor

In the present work, we showed that at least in case of Peking University and University of Tehran, there is a significant correlation between impact factor and tendency for archiving their (otherwise non-OA) articles in ResearchGate (section3.2). Interestingly, these two universities have the lowest rate of gold OA publication among the four studied universities. This finding can be explained by the fact that researchers in PU and UT, like other researchers, want to share their high-quality findings with other investigators. In fact, a 2011 survey on author attitudes toward OA (Kenneway, 2011) reported that 81.3% and 72.2% of participants from Iran and China, respectively, believed that OA publishing is important. Interestingly, in developed countries like Japan and the United States, the values are not as high (69% and 70.8%, respectively). Consequently, researchers in Iran and China may tend to publish in gold OA journals, but due to non-scientific reasons (e.g., lack of financial support for gold OA publication) they are not able to do so. In different surveys, it has been shown that in developing countries, where institutional support is limited, serious concerns may exist for those who cannot afford to pay normal OA publication fees (Schroter et al, 2005) and this may turn such a fee into an important factor in selecting the journal (Solomon et al, 2012). Consequently, they might use ResearchGate to freely share their work with others as gold OA articles.

In the present study, we showed that there is a significant positive correlation between full text availability and the citation count. Moreover, we showed that both post-print version and publisher's version (i.e., final published version) of the archived manuscripts receive more citations than non-OA articles. A possible drawback of our methodology is that the citation impact of full text and non-full text articles are not compared among papers of the same discipline. This issue may potentially influence the results, as both the shares of different access models and citation rates might be dissimilar among different subject areas. This drawback, however, may be alleviated to some extent by the fact that in our dataset, the ratio of papers within each subject area is fairly comparable (see Table 4). Therefore, we believe that our analysis can still provide insight about the citation trends of articles.

Subject area	Percentage
Medical Sciences	19.7%
Agriculture and Biological Sciences	17.6%
Physical and Chemical Science	18.1%
Engineering	13.6%
Art, Social sciences and Humanities	13.1%
Other	17.9%

Table 4. The ratio of papers in our dataset in each major subject area. Note that if all ratios were the same, one would expect each subject area to include 16.7% of all articles.

Conflicts of Interest: The authors declare no conflict of interest.

Abbreviations

The following abbreviations are used in this manuscript:

OA: open access

non-OA: non-open access

IF: impact factor

CC: correlation coefficient

KCL: King's College London

UCT: University of Cape Town

PU: Peking University

UT: University of Tehran

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