

Are Citation Data a Valid Measure of Journal Use? An Empirical Examination in an Academic Context

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Abstract

Citation and journal use data have both been used as tools to determine the quality and usefulness of a journal title, especially in academic libraries. However, both of these tools have been criticized for not accurately representing the full spectrum of journal use. With the increased popularity of online journals and the emergence of electronic journal usage data from publishers, there is another tool to potentially improve measurement of the use of journals. This study aims to determine whether these new electronic usage data correlate with more established print usage data and citation data, and to examine whether there is a difference between local citation data (citations by users whom the library serves) and a more global citation measure such as the journal impact factor, in measuring journal use. The findings show that the electronic journal usage measure looked at in this study correlates with the traditional print usage measure. In addition, it was found that local citation data are a valid measure of journal usage but that the more global measure of impact factors are not as valid.

Introduction

For many years, librarians and information scientists have struggled with how to best determine the value of a journal, either in the context of a library collection or a field of study. Libraries have developed a use-based measure, in the form of print re-shelving data or circulation data (if serials circulate), as one means of helping determine the value of a journal in their specific library collection. In contrast, citation measurement was developed by information scientists to give a broader, more research-based view of a journal's impact on a field of study. Citation data can be divided into two groups:

- a. Global citation data – this data is gathered by tracking the citation and publishing patterns of researchers at many institutions throughout the world. An example of this kind of data is that found in Journal Citation Reports (JCR), and a specific global citation measure is that of the impact factor.
- b. Local citation data – this uses data that is local to the institution. For example, the Journal of X was cited 10 times in 1998 by the faculty at University of Y. Such data can be obtained, for a fee, through Local Journal Utilization Reports, a product offered through the Institute for Scientific Information (ISI). It can also be collected locally by searching citation databases in the field(s) of interest.

Both print re-shelving data and citation data have been criticized for not providing a complete picture of journal use or value. Print re-shelving studies are expensive, time consuming, and not always accurate (Broadus, 1985). For example, users may re-shelve journals on their own; it is also difficult to determine how much use was made of a volume – the user may have glanced quickly at it or may have photocopied three articles. Both types of use will get equal weight in most re-shelving studies. In addition, print re-shelving studies are only of use for determining the usefulness of a journal in a single library, and cannot necessarily be extrapolated to make generalities about how important a journal is to an entire institution, as individuals at the institution may have their own subscriptions and might not use the library copy.

Citation data, although generally viewed as useful for evaluating research performance and, to a certain degree, journal impact within a field of study, are also controversial (Colquhoun, 2003; Nisonger 2004; Saha, Saint and Christakis 2003). The controversy partially stems from questions surrounding what motivates citation (for a good review on this issue see Liu, 1993) and also because they are not very timely in terms of providing feedback about what journals are currently cited. Also, citation data do not reflect use by those who do not publish; in an academic environment, this can include undergraduate and graduate students (a large and important user group for academic libraries), as well as staff and other users. Also, impact factors are universal and not specific to individual institutions with individual research/teaching missions. Local citation data (as in the type produced by ISI) must usually be paid for, which can make it inaccessible to some libraries. If the data is gathered manually, it is time consuming.

Previous studies have shown that global citation measures such as journal impact factor do not correlate significantly with use of print journals in libraries (Scales, 1976; Pan 1978). However, Stankus and Rice (1982) found that when journals were grouped by subject, scope and language, there was a significant correlation between journal impact factor and use of print journals. This was also the finding of Tsay (1998), who found a correlation between frequency of use and impact factor for titles that publish clinical medicine and/or life sciences articles; Tsay also found a significant correlation between frequency of use and worldwide citation frequency (as reported in Journal Citation Reports). Other studies looking at the relationship between the two have been somewhat inconclusive (Rice, 1983; Schmidt, Davis and Jahr, 1994; Wulff and Nixon, 2004).

Studies have also been conducted to determine whether data on local citation and publication patterns in certain journals correlate with a library's own measures of in-house use. Blecic (1999) found correlations between the following three measures: in-house use (using re-shelving data collected for one day a week from October 1992 to January 1994), circulation, and citation by faculty (obtained through ISI's Local Journal Utilization Reports), at the University of Illinois at Chicago's Library of the Health Sciences. Pearson and Spearman correlations between all the sets of data were statistically significant ($P < .0001$). However, Sridhar (1990) showed that locally collected (not from ISI) citation data for Indian space technology researchers did not correlate significantly well with library journal use.

With the emergence of electronic journals there comes a new ability to track use of electronic journals for which the library holds a subscription. Wulff and Nixon (2004) have shown that use of paper and electronic journal titles in an academic health sciences library correlate significantly ($p < 0.01$). They also found that the use of print and electronic journal titles correlates significantly ($p < 0.01$) with the titles' impact factors. However, they did not examine how the use correlates with local citation data which may be a more accurate measure of journal's local impact (Davis 2002). Kurtz et al. (2003) conducted a study looking at citations and reads of online articles in the Web-based NASA Astrophysics Data System. They found that the number of citations follows the number of reads very closely, thus proving the "normative theory of citing" (Liu, 2003) that "the number of times a document is cited ... reflects how much it has been used" (White and McCain, 1989, 119). Kurtz et al. rightly point to the need for further research in this new area of electronic journal use. They "expect the similarities and differences of reads and citations to become a central facet of bibliometric research ... the combination of the two measures of use substantially improves the capabilities of bibliometric measurement". (Kurtz et al., 2003, 127).

In a related but broader study on the relationship between electronic usage and citation, Perneger (2004) found a relationship between the total number of hits received by an article in the first week after publication in the online version of the medical journal BMJ, and the number of subsequent citations the paper received, as determined by ISI's Web of Science database. He concludes that "early hit counts capture at least to some extent the qualities that eventually lead to citation in the scientific literature" (Perneger, 2004, 3).

Such studies are of interest not only to librarians and information scientists, but also to researchers in other fields such as computer science and those studying the Web's role in scientific and/or scholarly communication. In recent correspondence to *Nature*, for example, Jon Kleinberg asked the question "how closely related are they [usage-based measures of impact] to traditional citation-based measures? We expect that there will be a rough correspondence between citation and usage in an aggregate sense – in other words, that a widely-read paper will show up in the bibliographies of many subsequent papers. However, there will clearly be deviations from this general principle" (Kleinberg, 2004, 1).

Building on these previous findings, this study aims to investigate whether citation data are a valid measure of journal use by examining the relationship among various measures of a journal's value. The emphasis will be on (1) the relatively new electronic journal usage data where little research has been done; and (2) local citation data which are theoretically a better measurement of the local use than the more global impact factor. Specifically, the following research questions will be addressed:

1. Do new electronic usage measures correlate with the more established print usage measure of re-shelving data?
2. Do citation data (local and global) correlate with journal usage data?
3. Is local citation data a better measure of journal use than the global journal impact factor?

Methodology

Data for all the variables listed below were collected at Concordia University Libraries. Concordia is a major Canadian university with an enrollment of over 31,000 students, and it has two campuses, both of which have a library. Print subscriptions are rarely duplicated between the two libraries, but electronic access to all journals is available whether on campus (at either library) or off campus, to faculty, staff and students.

Different disciplines have very different citation patterns and journal usage patterns. To ensure a valid examination of different variables and the compatibility of data, the study needs to be focused on a particular discipline. Journal titles from the subject areas of chemistry and biochemistry, as well as related areas, were used for the study and the details of data collection are described below.

Print re-shelving data

Print usage data was gathered through shelving studies. A total of 20 print journal titles from two different publishers were used: 11 from the American Chemical Society and 9 from the Royal Society of Chemistry. Titles used were those that Concordia Libraries had a current print subscription to at the start of the data collection period (June 2000), and for which continuous electronic usage data were available. Shelving staff in the Periodicals and Media Unit of both Concordia libraries collect data each time a bound volume or a loose issue of a journal is shelved. The data were reported for a full year only (usually the fiscal year, June 1 to May 31 of the following year). However, due to a transfer of certain volumes mid-year, some monthly statistics were available, thus enabling us to better match the time period of electronic usage data gathered (October 2000 to September 2003). Print shelving data were gathered for the period of June 2000 to September 2003.

Electronic journal usage data

All electronic journals used in this study are accessed only via publisher websites – these journals are not part of a large aggregator full text database, but are rather made available online directly through the publisher and as such are fully browsable and contain all text and images. Electronic usage data for the journals were collected via the electronic journal publisher's password-protected web site. Concordia does not collect electronic journal usage data through local library servers so the data collected from the publisher's web site were used.

For research question 1, data were gathered from two vendors: the American Chemical Society and the Royal Society of Chemistry. For research question 2, data from the American Chemical Society,

Royal Society of Chemistry, Elsevier, Wiley and Kluwer were used for all journals in the areas of chemistry and biochemistry, as determined by ISI. For all vendors, the data collected were the total number of HTML and PDF fulltext articles requested. This type of measure must be reported in Project COUNTER'S Journal Report 1 for a vendor to be considered Level 1 COUNTER compliant. Also, according to Shim et al. (2001), these numbers "provide a circulation count for electronic contents in a way analogous to the tradition circulation of books" (Shim et al., 2001, 5)

Time periods of data collection varied according to what research question was being examined. For question 1, electronic journal usage data were gathered for the period of October 2000 to September 2003. For question 2, data were gathered for different time periods according to different electronic journal packages (as these packages were acquired by Concordia at different times). Ranked lists of the most popular electronic journals were compared with ranked lists of the most popular journal titles for citation by faculty at Concordia. See Table 1 for a list of the publishers, how many titles were used from each package, and the time period for which data was collected. For some titles, there is missing usage data for a journal, probably due to a flaw in the vendor's reporting system or because a title changed vendors/publishers. Titles with any missing data were excluded from the study.

Table 1: Summary of Electronic Journal Usage Data

Publisher	Number of Titles	Time Period for E-journal Usage data
American Chemical Society	16	October 2000 to June 2004
Elsevier	77	January 2003-May 2004
Kluwer	12	January 2003- June 2004
Wiley	19	January 2003-June 2004

Citation data

Two kinds of ISI citation-based data were used in this study. Journal Citation Reports (JCR), which contain journal impact factors, were obtained for the year 2001 (Concordia Libraries had only paid for that year's worth of data). Library Journal Utilization Reports (LJUR) for Concordia University (science) were purchased from ISI. These reports give a measure of a) how many times researchers from Concordia published in each journal, and b) how often researchers at Concordia cited each journal in the study. The Reports were purchased for the years 1981-2002, however, in all parts of the study, only LJUR data from 1998-2002 were used to roughly match the time frames of other data collected for the study, yet still provide enough citation data.

For research questions 2 and 3, journal titles in the following ISI subject categories (for both LJUR and JCR data sets) were used: biochemistry and biophysics; chemistry; chemistry and analysis; inorganic and nuclear chemistry; pharmacology/toxicology; pharmacology & toxicology; physical chemistry/chemical physics. For all journals in these categories, the number of times the journal had been cited by all faculty members of Concordia (sum from 1998-2002, inclusive) was recorded.

Data Analysis

All sets of data were analyzed using SPSS software. Correlation tests were used to address research questions. First, the data were examined to see if the frequency distributions of data sets were skewed. If the data sets were not overly skewed, the Pearson test for correlation was conducted to test for correlation; if data sets were skewed, the Spearman test for correlation was used. Data analyses were carried out for each vendor separately because different vendors may use different methods to record electronic usage data (Duy and Vaughan, 2003) and thus their usage data are not always completely comparable. In addition, for some parts of the study, the data collection times varied by vendor, because of different acquisition times for different vendors.

Findings

Electronic Usage Correlates with Print Usage

As seen in Table 2, significant correlations were found between electronic journal usage data and shelving data for print journal titles for both publishers. It should be noted that, because only a small

number of titles in each package met the requirements for data collection (i.e., Concordia libraries had a current print subscription to the title in June 2000, and there was sufficient electronic usage data available from the vendor), only a very small sample size was used for each vendor. However, both correlation coefficients in Table 1 are very high, which provides assurance of the correlation found. The correlations suggest that the new electronic usage data can be used in place of the traditional re-shelving data, which are much more expensive to collect, and are becoming less relevant as more and more journals are available electronically.

It is worth noting that current journals in the Royal Society of Chemistry package were available in both print and online formats at Concordia, whereas for the American Chemical Society journals, the current print subscriptions to all but one journal ended in 2001. The fact that there is still a correlation for the American Chemical Society titles suggests that print and electronic use measures correlate even when there are current subscriptions for the electronic versions, but only back issues for print titles.

Table 2: Correlation between print journal use and electronic journal use

Publisher	N (number of journal titles used)	Pearson Correlation	Significance (p)
American Chemical Society	11	.766	<0.01
Royal Society of Chemistry	9	.876	<0.01

Local Citation Data Correlate with Journal Usage Data

As seen in Table 3, for three out of four journal publishers, electronic journal usage data for Concordia correlate significantly with local citation data of Concordia faculty (as determined by Library Journal Utilization Reports, which are defined above). Kluwer was the only publisher whose titles did not show this correlation. However, the lack of correlation should be viewed as an anomalous case because 7 out of the 12 journals used for this vendor showed a local citation value of 1, making these journals indistinguishable in the ranking process of the Spearman correlation test. Also of note is the fact that three of the 12 Kluwer journals used in the study are not from North America (two are from Russia, one is from Japan), which may also have an effect on the citation values (Vaughan and Shaw, 2005). The lack of significant correlation for this group of Kluwer journals thus does not refute the general pattern of correlation between the two variables.

Table 3: Correlation between Local Citation Data and Journal Usage Data

Publisher	N (number of journal titles used)	Pearson or Spearman test	Correlation	Significance (p)
American Chemical Society	16	Pearson	0.827	<0.01
Elsevier	77	Pearson	0.633	<0.01
Wiley	19	Pearson	0.585	<0.01
Kluwer	12	Spearman	0.099	0.761

No Correlation between Impact Factor and Journal Usage Data

Table 4 shows that the correlation between journal impact factors and electronic usage data is significant for only 1 out of 4 vendors. In addition, the vendor (Kluwer) that shows a significant correlation has a small sample size. It can thus be concluded that there is no relationship between the journal impact factor and electronic usage data, indicating that it is not really valid to use global impact factors for local collecting purposes in academic libraries, a practice that some libraries may have adopted due to the easy availability of the impact factor data.

Table 4: Correlation between Impact Factor and Journal Usage Data

Publisher	N (number of journal titles used)	Pearson or Spearman test	Correlation	Significance (p)
American Chemical Society	16	Pearson	0.047	0.863
Elsevier	77	Spearman	0.081	0.483
Wiley	19	Spearman	0.264	0.275
Kluwer	12	Spearman	0.724	<0.01

Discussion and Conclusions

This study indicates that electronic usage data, as provided by most publishers of electronic journals, correlate significantly with print usage data in the areas of chemistry, biochemistry, and related fields. Wulff and Nixon (2004) found a similar correlation in their studies of health science journals (it should be noted that they used the same measure of electronic journal usage as in this study– the sum of HTML and PDF fulltext articles viewed). The results of the two studies suggest that, for electronic journals, vendor-supplied electronic journal usage data – in the form of PDF and HTML views- can replace the traditional and time-consuming way of determining library use of journals: print re-shelving studies.

The correlation indicates that the new electronic journal format does not appear to have had an effect on journal preferences among users. It also indicates that some long-standing criticisms of print re-shelving studies (for example, that users can easily re-shelve journals on their own, and thus the use of that issue or volume would not be counted, or that such studies could not effectively count how many articles were looked at in a single volume or issue) have not affected the general accuracy of print re-shelving data in terms of providing a measure of the ranked popularity of journal titles. The results for the American Chemical Society journals also indicate that electronic journal usage data continues to correlate with print journal usage data even for print titles that are no longer currently subscribed to by the library.

Results from this study also indicate that local journal citation data significantly correlate with electronic journal usage. The correlation coefficients for Elsevier and Wiley, though significant, were not as high as for the American Chemical Society journals. However, it is worth noting that at the time of the study, Concordia had had access to the American Chemical Society for approximately 4 years, whereas access to the other two packages had only been in place for 1.5 years. This difference may have affected the strength of the correlations for Elsevier and Wiley titles, and more research should be conducted to see whether electronic journal packages take time to display “established” usage patterns.

This study also found that the global measure of journal impact factor did not correlate with electronic usage data. This finding agrees in principle with that of Davis (2002) who found that the most popular journals as determined by examining where researchers from Cornell publish did not match with the journals in those same subject areas with the highest impact factor. Davis concludes: “The generic metrics of the JCR simply cannot provide the campus-level data crucial to making informed decisions about the local importance of individual titles” (Davis, 2002, 161). However, the finding in this study is in contrast to that of Wulff and Nixon, who did find a significant correlation between print and electronic use of journals in an academic health sciences library, and their impact factors. Others (Stankus and Rice, 1982; Tsay, 1998) have also found a significant correlation between print use and journal impact factors, but none of these studies did a direct comparison of the correlation between usage and impact factors versus usage and local citation practices as our study did.

It may be that significant correlations between library journal use and impact factors were affected by the design of the study or that the correlation exists for particular fields (for example, two of the studies where a correlation was found between impact factor and use were conducted in health sciences/medical libraries) or at certain institutions. The results may also have been affected by

researchers having their own personal subscriptions to high-impact journals in their areas of study, and they may consult these personal copies (either in print or online) rather than a library copy. Further research is needed to reach a firmer conclusion on the impact of these issues. Nevertheless, findings from the current study call into question using global impact factors for local library decisions on journal collections.

The findings of this study not only contribute to our knowledge of citation data (local citation is a valid measure of journal use while global impact factors may not be) but also address practical questions of academic library collection measures. For example, the results from this study indicate that, although reading an article and citing an article are different activities, and perhaps indicate different usefulness of an article, there is an overall correlation between journals that are looked at online, and those that are cited, something that one could not necessarily assume at an academic institution where non-publishing students are presumably a large population of online journal readers. It could be expected that, in a setting where *all* users of online journals are researching and publishing (e.g. a research center), such a correlation may even be stronger. It should be noted that the conclusions from the study are based on a single university library and on particular academic fields. More research needs to be conducted to determine whether the conclusions can be generalized to other areas of academic study before electronic journal usage data become a standard tool in helping shape journal collections. Meanwhile, other more subjective and traditional means of evaluating library journal collections (e.g. consultation with faculty) should still be used in combination with the newer electronic usage data.

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