

BRIEF COMMUNICATION

A Longitudinal Study of Scholars Attitudes and Behaviors Toward Open-Access Journal Publishing

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This research applies statistical time series analysis to examine the changing pattern of scholars' attitudes toward open-access (OA) journal publishing from the early 1990s. By synthesizing survey results in existing studies, this research focuses on representative aspects of the attitudes and behaviors recorded through the years. It finds that although an increase in the publishing and awareness rates of scholars with regard to OA journals has been observed, scholars have been consistently concerned with the low prestige of such journals and their lack of peer review, which is not the case in practice. It is hoped that the findings will provide useful information for the improvement of OA advocacy.

Introduction

Open access (OA) journal publishing is one of the primary OA publishing formats in practice for delivering research results to the public free of charge. The others are through OA repositories and personal/departmental Web sites. Publishing articles in an OA journal entails a peer-review process and requires original contributions, identical to traditional scholarly journal publishing, providing necessary control over research quality. OA journal publishing is supported by several different business models which range from an "author-pay" system to a "toll-free" system that relies on financial sponsorship from institutions and grant agencies. This unique way of online distribution enables research to be shared more quickly and broadly than that through traditional print publishing.

The origins of OA journal publishing can be traced back to the earliest appearance of electronic journals as experiments in the 1970s (Hiltz & Turoff, 1978; Senders, 1977), although real peer-reviewed, born-digital journals did not start until

some two decades later. The issuance of *Psychology* in 1989 symbolized the beginning of an OA journal proliferation in the 1990s and has continued since (Harnad, 1990; Suber, 2009). As of Summer 2009, the Directory of Open Access Journals (www.doaj.org) contained a total of 4,220 OA journal titles, extending to almost all academic fields.

In the beginning, OA journals differed in policies; some provided only abstracts and others full articles, while some delivered via file server and others by e-mail. Early electronic journals included peer-reviewed scholarly journals as well as nonscholarly publications such as newsletters. OA journals were sometimes muddled with electronic journals that were issued by commercial publishers with restricted access and print counterparts (Lancaster, 1995; Roes, 1995; Schauder, 1995; Tomney & Burton, 1998). The policies were gradually standardized, allowing OA journals to be readily accessible online to all areas of the world, with a professional-style design. By 2004, as many as 1,200 journals which consisted of about 5% of the total peer-reviewed journals in the world were OA journals, so-called *gold* journals by Harnad et al. (2004). This number has kept growing.

The attitudes and behaviors of scholars as journal-article authors will directly determine the health of OA journal publishing. Their engagement in OA publishing is based on their acquaintance with OA ideas and practices. It is generally believed that their familiarity has increased over the years; consequently, their involvement also has increased (Morris & Thorn, 2009). OA advocates, practitioners, and other researchers have been careful in monitoring the change of scholars' attitudes and behaviors over their collaborations with OA publishing with the intention of providing valuable insights into how to best improve OA journals and educate scholars about the potentials of OA journal publishing.

One of the earliest surveys on authors' awareness, experience, and concerns for OA possibilities was Schauder's (1994) project among scholars in Australia, the United Kingdom, and the United States for "an assessment of the

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position of academics in relation to electronic publishing” (p. 73). Since then, surveys on this topic, though with diverse respondents, have been undertaken in every consecutive year until the new millennium (e.g., Anderson, Sack, Krauss, & O’Keefe, 2001; Björk & Turk, 2000; Budd & Connaway, 1997; Lancaster, 1995; McKnight & Price, 1999; Palmer, Speier, Wren, & Hahn, 2000; Shamp, 1992; Speier, Palmer, Wren, & Hahn, 1999; Sweeney, 2000; Tomney & Burton, 1998). These reports presented a clear picture of the early perceptions and practices of digital scholarly communication.

More surveys among authors have been conducted during this decade than that during the previous one. The most well-known include Swan and Brown’s (2002, 2003) project on a group of journal authors world-wide in late 2001 and early 2002. A year later, the same researchers carried out a comparable survey for similar purposes (Swan & Brown, 2004a, 2004b). Almost concurrently, another report was issued in early 2004 based on an international survey of author opinions among a much larger group of scholars (Rowlands & Nicholas, 2005; Rowlands, Nicholas, & Huntingdon, 2004). Additional examples include large-scale surveys among international scholars by Swan and Brown (2005), and Hess, Wigand, Mann, and von Walter (2007) and surveys limited to scholar groups targeted either geographically or institutionally by Over, Maiworm, and Schelewsky (2005), Kennan (2007), Ghane (2007), and Austin, Heffernan, and David (2008). Small-scale surveys also can be found sporadically such as work by Morrison, Waller, and Vézina (2006) and Warlick and Vaughan (2007).

In reading these studies, it becomes evident that their findings are consistent in some areas, but conflicting in others, which may be due to differences in survey times or study populations. For example, while it is apparent from most studies that scholars have become more knowledgeable about OA journal publishing and have expressed their plans to contribute to OA journals in the near future, no concrete evidence has been discovered to illustrate that their willingness had been translated into actions. While the top reason for scholars to choose a journal in which to publish articles has always been the journal’s prestige, as reflected by its high impact factor and citation rate, the percentages of their actual working with OA journals has fluctuated from year to year. Furthermore, such observations are scattered, making difficult a fuller understanding of the change of scholars’ attitudes. There is no single study synthesizing these isolated surveys, but such a synthesis will be able to highlight scholars’ ongoing experience in OA experimentation and reveal how the experience has correlated with the advancement of OA journal publishing throughout the years.

This research will apply a longitudinal approach to synthesize previous observations of journal authors’ opinions and examine possible trends of attitude and behavioral changes of scholars. A longitudinal study is a correlational research appropriate for capturing changes through time (Veldman, 1997). The concentration of the synthesis and analysis will be on scholars’ understanding of OA journal publishing and

willingness to contribute to such journals. Their reasons to publish as well as not to publish in the journals will be compared across surveys from different dates to see if scholars’ views of OA follow a chronological pattern. If time is meaningful for OA advocacy, there should be a steady increase in scholars’ awareness and motivation toward OA journal publishing during a multiyear interval.

Methodology

Data Selection

Literature was carefully reviewed to locate published material on this topic. There are numerous studies focusing on the perceptions and experience of scholars from a publisher’s, editor’s, or reader’s perspective; and users’ experience is particularly popular in the literature (e.g., Tenopir & King, 2008). Although these studies have provided useful information, few of them contain piecemeal data of interest to our analysis. Another concern in data selection was the diverse policies of electronic journal publishing in the early 1990s, when varied definitions of “electronic journals” were applied. Some studies, though using the same term, discussed issues other than electronic journals for OA; these were excluded from the analysis.

To carry out a quantitative analysis, studies that did not provide statistics were not included in the list of analyzed sources, although they were consulted to assist with the analysis for the purposes of understanding and interpretation. Interviews generally belong to this category. In contrast, lengthy reports based on scientific surveys were the best sources, and journal articles and concise slide presentations served as complements.

Data were searched through the following channels:

- General search engines, mainly Google and Google Scholar
- General literature databases such as Academic Search Premier and Social Science Research Network
- Literature databases in the field of library and information science, such as Library Literature and Information Science Full Text
- Citation references of relevant studies, the primary method of expanding the list of important surveys on the topic
- Scholarly electronic-publishing bibliographies such as one compiled by Charles W. Bailey (2009) and reviewed annually
- Contacting authors of certain important surveys.

It was fortunate that a group of extensive reports representing systematically designed surveys existed and had been collected for each year since 1991 until now. For some years in the early 1990s, only one report could be identified to represent a year. We had no choice but to incorporate them into our analysis. For the most recent years, though, there were multiple reports discovered for each year, requiring the development of a data-selection strategy through which the most suitable surveys could be identified.

The *Cochrane systematic review* principles were adopted to guide data selection (Cooper & Hedges, 1994; Higgins & Green, 2008). Although the Cochrane review format primarily aims to help researchers evaluate and prepare evidence for

healthcare-related studies, its standards on synthesis of the available evidence on a given topic are applicable to research in many other scientific fields. Basically, the Cochrane review for eligibility criteria emphasizes the assessment of a set of prespecifications to seek all rigorous candidates for statistical analyses. The prespecifications may include, but are not limited to, the evaluation of the participants, interventions, and comparisons in studies, each of which is discussed next.

Participants refers to people or a population of studies and focuses on the sufficiency and broadness of any study population so that meaningful answers can be obtained. Characters of study populations, such as age, sex, and educational status, should be examined to determine special groups of interest.

Many of the surveys that were discovered were carried out among scholars on a world-wide level. According to the demographics described in these reports, the majority of respondents were from Europe, North America, and Australia and were clustered in higher educational institutions. Thus, their views were mainly Western-oriented and academic. Another group of projects limited their surveys to a particular country (e.g., Australia, Canada, Germany, or the United States) or even a subgroup (e.g., senior scholars, faculty in one university system, or researchers sponsored by the German Research Foundation). Although the incorporation of the subgroups into our analysis was minimized whenever possible, the comparison of single-country surveys with international surveys was inevitable. Several reasons made the comparisons dependable: (a) The international surveys selected in this analysis consisted of scholar populations in the countries where the single-country surveys were taken; (b) a simple random-sampling strategy (or other random-sampling strategies) was applied throughout with a few exceptions, thereby reducing biases; (c) almost all sample sizes were large enough (many had more than 1,000 respondents) to minimize possible errors; and (d) all findings incorporated into this analysis were “generic” ones that tended to reflect the very basic aspects of scholars’ attitudes and behaviors, and any questions local to individual surveys were excluded.

Interventions specifies the interventions of interest and the interventions against which these will be compared. In healthcare settings, there may be complex interventions in review, and the studies usually use experimental formats. This study only took the simplest form and concentrated on what was the most applicable representation of “intervention” for the analysis: time as the independent variable.

This research applies statistical *time-series analysis* to the data collected and synthesized. Time-series analysis is modeled to handle consecutive measurements taken at “equally spaced” time intervals, although our data do not represent perfect, “equally spaced” time intervals. “Year” is the interval unit of this analysis, although some surveys were taken in the beginning of a year whereas others were in the middle or the end of a year. In addition, there are surveys spanning 2 years from the beginning of the projects to their conclusion. There are no studies which included adequate data to represent seasons or even months, unfortunately, and assigning reports to characterize a year is somewhat artificial.

Nonetheless, this study accepts this irregularity because attitude changes could not be as sensitive as to months when there were no intentionally designed intensive treatments involved, except for the time as a process of treatment. Yearly measurements were considered to be adequate. Here, the *year* representation refers to the time for the actual conduct of a survey rather than the time for any pilot survey or for publication which could significantly lag behind a survey.

Comparisons refers to the fact that although a Cochrane review typically does not include outcomes as part of the assessment criteria, some reviews do legitimately restrict eligibility to specific outcomes based on the very nature of individual studies.

In our data, all survey questionnaires were organized in different ways, which made the data normalization a challenging job. Questions were not only structured and verbalized differently but the measurement mode also varied from survey to survey. For example, a “yes/no” category-type answer might provide less meaningful information than would a 7-scale Likert selection for a quantitative analysis, and aggregated data could impede statistical breakdown of discrete values. Furthermore, content coverage in some reports was wider than in others, and content focus could have shifted considerably from one survey to the others, making the initial evaluations discouraging. This research finally adopted the solution of selecting those questions that could deliver answers about the very basic aspects of scholars’ attitudes and behaviors and by downscaling the data to ratings and percentages. We hoped that these decisions would be able to keep at a minimum the problems caused by the content discrepancy.

A list of surveys was eventually identified that chronologically represented different stages of OA journal publishing (see Table 1). Inevitably, data for certain variable(s) were totally unavailable for a single year; however, this was relatively uncommon and was handled later in the statistical-analysis stage.

Data Normalization

Except for several reports that were undertaken by the same researchers at different times, all other works were individually designed, conducted, analyzed, and written. Even the former studies contained differences in their scope, population, and sample size. Thus, tremendous effort was made to select and normalize the data.

Data normalization is a process that allows underlying characteristics of the outcome datasets to be compared. There are various normalization strategies. Normalization in statistics commonly involves the standardization of different data scales and the recategorization of research questions and answers. This analysis followed statistical normalization principles and focused on several research questions pertaining to the topics of interest.

Table 2 shows the areas of interest for this analysis. These areas are *awareness*, *action*, and *attitude*, each of which is supported by several questions extracted from the original

TABLE 1. Main sources selected for the analysis, where surveys in parentheses are the secondary sources.

Year represented	Survey time	Source	Sample size	Population
1991	1992	Shamp, 1992	81	USA
1992	1992	Schauder, 1994	582	Australia, United Kingdom, USA
1993	1993–1994	Lancaster, 1995	150	USA
1994	1994	Butler, 1995	481	Multiple countries
1995	1995	Budd & Connaway, 1997	651	USA
1996	1996	Tomney & Burton, 1998	147	United Kingdom
1997	1997	Palmer et al., 2000; Speier et al., 1999	300	USA
1998	1998	McKnight & Price, 1999	537	United Kingdom
1999	1999	Swan & Brown, 1999	2,500	Multiple countries
2000	2000	Bjork & Turk, 2000	236	Multiple countries
	2000	(Sweeney, 2000)	62	Florida State University System
2001	2001	Anderson et al., 2001	104	Multiple countries
2002	2001–2002	Swan & Brown, 2003	1,246	Multiple countries
2003	2003–2004	Rowlands et al., 2004	3,787	Multiple countries
	2003–2004	(Swan & Brown, 2004a)	311	Multiple countries
2004	2004	(Over et al., 2005)	1,028	Germany
	2004	Swan & Brown, 2005	1,296	Multiple countries
2005	2005	Rowlands & Nicholas, 2005	5,513	Multiple countries
	2005–2006	(King et al., 2006)	49	University of California, Berkeley
2006	2006	(Morrison et al., 2006)	150	Canada
	2006	(Kennan, 2007)	202	Australia
	2006	Hess et al., 2007	688	Multiple countries
	2006	(UC, 2007)	1,118	USA
2007	2007	Austin et al., 2008	509	Australia
	2007	(Brown & Swan, 2007)	2,250	United Kingdom
2008	2008	Morris & Thorn, 2009	1,368	Multiple countries

TABLE 2. Areas of interest for analysis.

Construct formed	Question normalized	Answers selected	Scale adjusted
Awareness	Do you know the existence of an OA journal in your field?	Yes/No	Percent
Action	Did you publish in any OA journal in the past?	Yes/No	Percent
	Will you plan to publish in OA journals in the near future?	Yes/No	Percent
Attitude	What are your reasons to publish in journals in general?	To share with peers	Ranking
		To gain reputation	Ranking
	What are your reasons to publish in OA journals?	Free access	Ranking
		Publishing speed	Ranking
	What are your reasons not to publish in OA journals?	Low prestige/impact factor	Ranking
		Lack of peer review	Ranking

OA = open access.

surveys. The awareness variable was measured by the question “Do you know the existence of an OA journal in your field?” which was expressed differently in individual reports. The answers in the reports were designed to be either “yes/no” pairs or a Likert scale. When scaled measures were taken, the most frequent terms used included, among others, “very high” and “high” or “a lot” and “a little.” In the normalization step, both “very high” and “high” (or “a lot” and “a little”) were modified into a “yes” answer because this analysis is only interested in whether scholars know the practice of OA journal publishing, not their degree of familiarity.

The action variable was examined through two questions: “Did you publish in any OA journal in the past?” and “Will you plan to publish in OA journals in the near future?” For the first question, the answer in the original reports was either “yes/no” or was designed to record the actual number of articles in OA journals. For example, the respondents might be

asked to select among having published one, two, or three or more articles. Again, it is irrelevant to this analysis to know how many OA articles have been published. The answers to the second question in several original reports identified the respondents’ planned publishing time for OA articles: the next 6 months, 12 months, and so on. Likewise, this time specification is irrelevant. In this analysis, publishing action was recorded as “yes” for any amount already published and for any intention to publish in the future.

For the attitude variable, the original questions were transformed into the following: “reasons to publish in journals in general,” “reasons to publish in OA journals,” and “reasons not to publish in OA journals;” the last of which reflects the concerns of scholars toward OA journal publishing. For all these questions, most of the surveys provided a list of reasons for the respondents to select as their answers. Depending on the rates of the respondents’ selections, reasons were

subsequently ranked for the frequency of each selection in the original reports. To simplify this analysis, the top-two most frequently selected reasons were singled out for comparison. Hence, the reasons for the first question are *share with peers* and *gain reputation*; for the second question, *free access* and *publishing speed*; and for the third question, *unfamiliarity* and *low prestige* (indicated by low impact factor/citation rate and no peer review). This analysis was interested in comparing how each reason has been rated across time.

This selection of sample variables from a pool of possible answers seems to expose the research to threats of internal validity; that is, leaving other variables unmeasured. The questions selected for the areas of interest in the research represented only a small fraction of most surveys' content; however, they were the most descriptive ones to sufficiently reflect scholars' attitudes and behaviors for the purpose of this analysis. They also constituted the core questions that were covered in almost all the surveys, which made a cross-study comparison feasible. These two reasons were ranked at the top over nearly 90% of the surveys and through the time span of 20 years. In addition, the explanations sought by this analysis are not exclusive. Altogether, this means that the selected definitions and concepts give a reasonable view of the subject, and allow aggregated analysis, which improves overall validity.

The sample sizes of the individual surveys were all different. No effort was made in this analysis to weigh each into a combined average. Instead, the analysis relied on the percentages of the original measures to make necessary comparisons to maintain data integrity.

There are some limitations to this analysis. The heterogeneity of the content of these surveys restricted the ability to explore the differences in scholars' attitudes across various academic fields, such as sciences versus social sciences, which would be valuable information to distinguish disciplinary cultures in information sharing. Unfortunately, relevant data and reasonable analyses were missing from too many surveys. This is a drawback of some longitudinal studies that rely on historical data, especially when a longitudinal study is constrained to a short time span, as this analysis was. Likewise, this analysis was not able to make comparisons among scholars of different geographical locations, another important factor for contributing to the understanding of the whole picture. The differences of a scholar's academic rank also were not included due to the available data; thus, we were not able to distinguish between junior and senior scholars and establish correlations, if any, between OA development and scholars' positions in OA.

Data Analysis

Time-series analysis was selected to statistically make the comparisons through time because this method is applicable to a collection of quantitative measurements taken at regular intervals through repeated surveys. For our analysis, the interval was set to *year* and started from 1991. Additionally, because time-series analysis assumes an internal structure

(e.g., trends) in interval data points, it is appropriate for modeling changes in scholars' attitudes and behaviors as a longitudinal study.

With time-series analysis, there are many statistical models designed for various data types and analytical purposes. The most suitable model for this analysis is exponential smoothing because of its advantages in weighing heavily the most recent observations for forecasting and in handling trends with no seasonality. Exponential smoothing also has an advantage over the Box–Jenkins time-series analysis model, which requires 50 or more successive values. Here, the double (or Holt) exponential smoothing scheme was employed to model linear temporal data.

What exponential smoothing does is to assign exponentially decreased weights as the observations in a time series get older. To determine the weights, smoothing parameters are to be determined or estimated. For double exponential smoothing, two such parameters are required with the symbols α and γ , which also are known as the smoothing constants. The normal way of determining their values is through nonlinear optimization techniques such as the Marquardt Algorithm. The basic principle is that these values should be selected to result in the lowest possible *MSE* when comparing the original series to the forecasts.

There are two equations associated with double exponential smoothing:

$$\begin{aligned} S_t &= \alpha y_t + (1 - \alpha)(S_{t-1} + b_{t-1}) & 0 \leq \alpha \leq 1 \\ b_t &= \gamma(S_t - S_{t-1}) + (1 - \gamma)b_{t-1} & 0 \leq \gamma \leq 1 \end{aligned}$$

where S_t stands for the smoothed observation and y stands for the original observation. Note that in the first equation, S_t is adjusted for the trend of the previous period, b_{t-1} , by adding it to the last smoothed value, S_{t-1} . This works on eliminating the lag and bringing S_t to the proper base of the current value. The second equation works on updating the trend, which is expressed as the difference between the last two values.

In general, time-series analysis provides a mechanism to help understand a sequence of data points by illustrating the underlying context of the data and by relying on observed values to predict future values. Upon appropriate examination, patterns of observed time-series data can be identified, which in turn can be more or less formally interpreted and integrated with other types of data and analysis such as qualitative descriptions. Regardless of the extent of understanding and the validity of interpretation of the phenomenon by the time-series analysis, it is at least possible to extrapolate the identified pattern to forecast future events.

SPSS Version 17.0 was used to perform the time-series analysis. Before applying its forecasting function for the exponential smoothing, data were readjusted by running the "replacing missing values" command (that implements the *MLE* principles) to fill in missing values for some spots in the series; this consisted of around 15% of the total points. Time-series analysis does not allow missing values within a series. Data absent at the beginning or end of the series were disregarded, however, because hypothetically

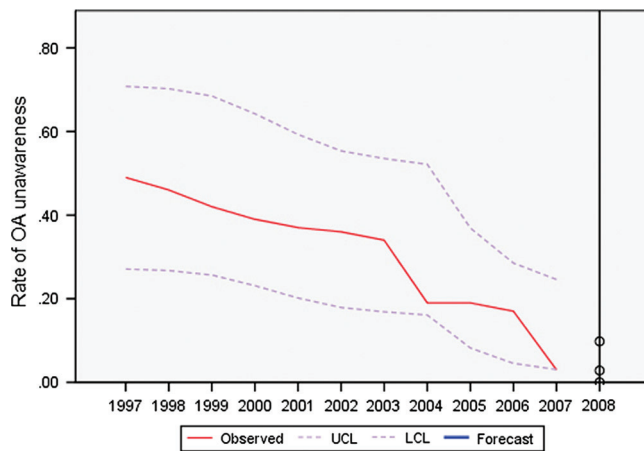


FIG. 1. A chronological change of open-access unawareness rate.

they would not affect the time-series analysis. For forecasting, the 95% confidence interval was applied.

Results

Awareness

Are scholars aware of OA journal publishing? The percentage of respondents answering “no” to this question has declined steadily through the years. Pearson’s correlation coefficients of the observations on this variable help verify an obvious trend of decrease ($r = -0.96$). In time-series analysis, the reduction in unawareness rate started from the mid-1990s and will continue beyond the series (Figure 1). The rate was as high as around 50% at the beginning of the series, but dropped to below 15% by 2007, probably indicating that the majority of, if not all, academic disciplines now have some OA electronic journals and that the majority of, if not all, scholars know of this new publishing channel.

Here, *awareness* refers to the fact that scholars know of the existence of OA journal publishing; however, it does not describe the degree of awareness. In fact, many scholars surveyed were not able to tell the difference between an OA journal and a subscription-based electronic journal; some of them may not have realized the existence of OA. A 2008 survey by Morris and Thorn (2009) found that “not all were clear about what OA journals actually were” (p. 223). Necessary clarifications on scholars’ understanding of OA journal functions have not been the focus of the majority of the surveys; thus, no such data have been incorporated into the time-series analysis.

Action

Figure 2 shows a trend of gradual increase in the number of scholars actually publishing in OA journals over the years. This may reflect a growing number of OA journals available to scholars in many academic fields and an increasing awareness of such journals by scholars. In contrast, also

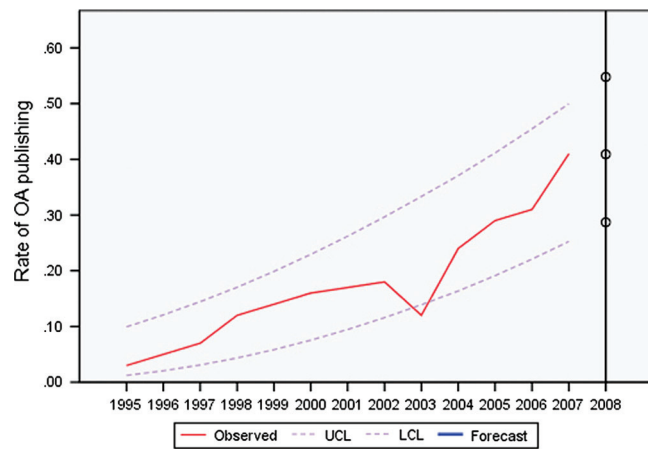


FIG. 2. A chronological change of open-access publishing rate.

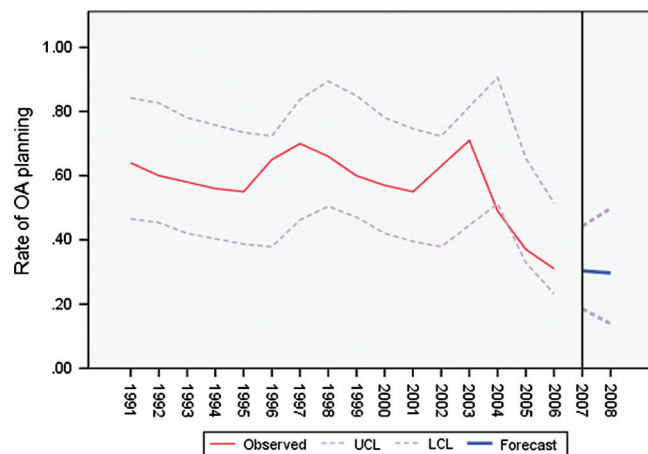


FIG. 3. A chronological change of open-access publication planning rate.

note that although the rate started very low in the mid-1990s, it still did not reach a high level by the end of the sequence of observations, even with a detectable, continual rise. This may indicate a relative hesitation among scholars for making contributions to OA journal publishing.

With regard to scholars’ willingness to publish articles in OA journals in the future, a confusing picture is seen (Figure 3). Data collected after 2005 showed a decreased rate of scholars’ willingness, which may not have a reasonable explanation. Its rather zigzagged distribution over time is difficult to interpret appropriately and challenges accurate forecasting by time-series analysis. When the results are compared with the positive publishing trend as shown in Figure 2 and the negative unawareness trend in Figure 1, it also is difficult to construct any meaningful correlation. The confusion possibly is caused by the raw data in the original surveys or by the data-normalization process because in comparison with other survey questions, this question was either articulated too ambiguously or missing from some surveys. An alternative explanation is that scholars tend to support OA publishing more in theory than in practice (Morris & Thorn, 2009, p. 236).

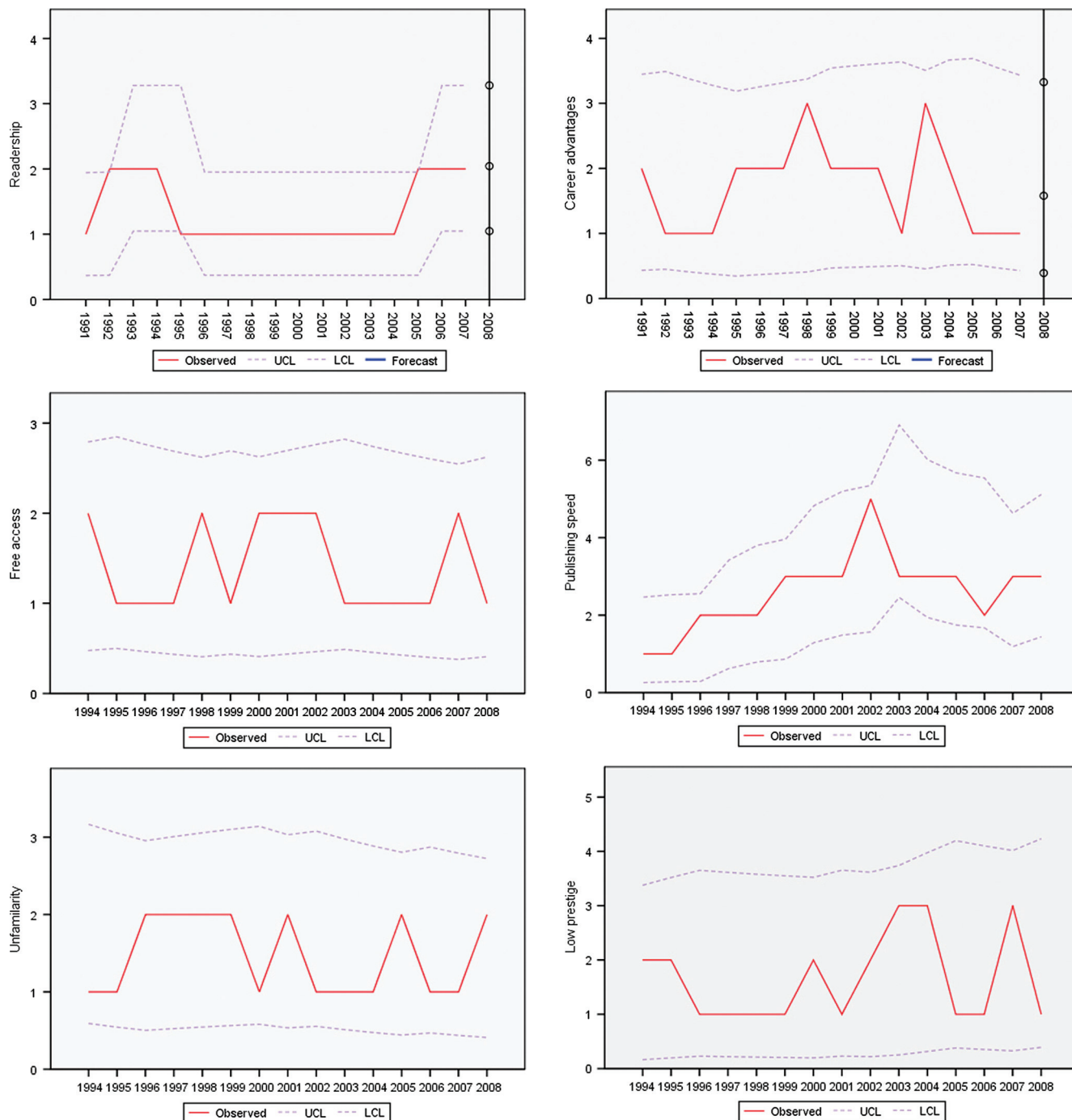


FIG. 4. Change of scholars' recognition of open-access readership.

Attitude

What are the reasons that drive scholars to publish their articles in academic journals in general? This question was selected for the purpose of making comparisons to the reasons to publish in OA journals in particular. Respondents selected many reasons for the former question, and might have selected more had they not been restricted by a list of answers provided by the surveyors. The most important reason in most surveys was to communicate with peer

researchers, particularly peers in the same interest area. Readership was, therefore, the primary consideration for publication. Respondents also liked to gain personal reputation through publishing research results, a reason that was second in importance. No matter to which academic discipline the scholars belonged, they shared the same interests (see Davies & Greenwood, 2004). When temporal data are examined, a uniformity of the ranking of the reasons is exhibited (Figures 4a and 4b); namely, there is no obvious change of

scholars' attitudes over the time span of this research, and the trend will most likely continue.

As for the reasons to publish in OA journals, scholars primarily favor the free accessibility of journal articles. They wish for their research to reach out to a broad readership and be shared by others without restrictions, which is a reason perfectly correlating to the most important factor compelling scholars to publish in journals in general. The second advantage of publishing in OA journals, as recognized by the respondents, is the pace of online publishing. Scholars are tired of long publishing cycles in traditional print and hope the OA model can speed up the process. The time-series analysis does not show noticeable changes from year to year for both reasons (Figures 4c and 4d).

Answers to the reason "to not publish in an OA journal" reflect well the concerns of scholars about OA publishing. Most scholars complained that they are not familiar with OA journals. This is different from the answers for scholars' awareness of OA journal publishing. In other words, one may be aware of the existence of OA journals, but be unfamiliar with their operations such as how submission, review, and production are handled or how copyrights of online materials are regulated. Figure 4e shows a slight improvement in scholars' familiarity with the operation of such journals since early in the new millennium.

An equally important concern of scholars about OA journal publishing is the prestige of the OA journals. It has been commonly believed by scholars that OA journals have a low impact factor and receive low citation rates. This misunderstanding of low citations neglects the fact that OA publishing has created a dramatic impact on citation patterns (Harnad & Brody, 2004; Kurtz et al., 2004; Lawrence, 2001; Odlyzko, 2002). Among other changes, an obvious increase in the citation counts of OA publications has been discovered. A more recent study published in *Science* by Evans (2008) confirmed this discovery (p. 398).

In addition, peer review is typically not connected with this innovative publishing model. In questioning the quality of OA journals, scholars are afraid that their scholarly careers can be negatively affected if they keep publishing articles in these journals, which can directly influence their promotion and tenure (see discussion in Cronin & Overfelt, 1995). Although scholars' concerns about this point have fluctuated throughout the years, there has been no large change observed in this analysis (Figure 4f).

Note that there are many other answers through which scholars' attitudes toward OA journal publishing can be measured. Sometimes other reasons were weighed close to, if not equally or even more frequently than, the reasons examined earlier in the original reports. This selection of two reasons per answer was set for the purpose of simplifying the analysis. Yet, it also is true that these reasons were not only more frequently picked by respondents but also represented the reasons that overlapped in most surveys. Some other reasons may have been individualized in particular survey questionnaires and were not uniformly available throughout the surveys.

Conclusion

In this research, time-series analysis has demonstrated its strengths for modeling changes observed over regular time intervals. Although the surveys used in the analysis are scattered and not in coherent streams or sequential extensions, this study has been fortunate to assemble, through data selection and normalization, a group of survey results representing each year since the early 1990s. It is an appropriate fit for surveys covering the 20-year time to match the life span of the OA movement and OA journal publishing. The richness of the investigations reflects people's ongoing interest in OA. We will expect to read more surveys on scholars' attitudes and behaviors about OA publishing in the future as a result of increases in the involvement of policy makers and young scholars in OA. It is hoped that future studies of this type can learn from the design of previous surveys so that standard survey instruments can be set to generate evidence to reveal the trajectory of OA development with reference to the changes of scholars' cooperation.

As expected, the analysis has discovered a steady increase in the number of scholars participating in OA journal publishing alongside the increase of scholars' awareness of the new scholarly communication. These represent the main trends of OA development with statistical significance. After nearly 20 years of practice as well as efforts in OA advocacy, many more scholars have become conscious of OA journals today than they were in the early 1990s. Contrarily, the analysis did not detect an obvious change in scholars' concerns of OA journals for the low reputation of such journals as well as their perceived lack of a peer-review process. Therefore, the time-series analysis did not discover a clear changing pattern in scholars' willingness, with random fluctuations through the years. Even the expressed willingness may not necessarily translate into the actions of scholars to really publish in OA journals, probably due to the psychology of survey responses (see Tourangeau, Rips, & Rasinski, 2000) or a discrepancy between supporting OA publication in theory and in practice (see Morris & Thorn, 2009).

These findings may help alert OA advocates and managers of the weaknesses in their previous efforts and indicate possible areas to improve in the future. Although variations in scholars' attitudes and behaviors have been noticed by researchers, longitudinal research on historical data has allowed us to view them in a systematic way, and a forecasting study has provided us with useful tools to see the direction of the enterprise.

Because of the individual design of the original surveys with dissimilar research concentrations, there lacks standardization in the structure of survey questions, which makes data synthesis and normalization across surveys difficult. For example, this analysis had to sacrifice comparisons among scholars across academic fields and ranks primarily because of the absence of such data in some reports. However, sacrifices like this have been alleviated by an analysis at the aggregate level to provide a whole picture of scholars' attitudes and behaviors. Changes, either observed or predicted

in the time-series analysis, have been and will continue to follow a positive direction.

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