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メタデータ	言語: English 出版者: Springer Nature 公開日: 2023-11-30 キーワード (Ja): キーワード (En): 作成者: 浅井,澄子 メールアドレス: 所属:
URL	http://hdl.handle.net/10291/0002000131

Access Patterns of Electronic Articles: The Case Study of *Scientometrics*

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Abstract

Most leading publishers provide access to articles released online ahead of print publication; however, the relationship between print publication and electronic access has seldom been examined. This study investigated the effects of online release on readership by examining the weekly accesses to 75 articles released online between December 2019 and March 2020 in *Scientometrics*, a hybrid journal. The results revealed that the electronic access increased rapidly following the articles' online release, but declined immediately, and increased again after the print publication. Publishing articles in two formats not only enables speedy distribution of research, but also increases the electronic access to journals.

Keywords: access pattern, open access, Altmetric score

Introduction

Given that the authors expect their articles to be speedily accepted and published, the time lag from submission to publication is one factor in the journal selection process (Solomon and Björk [20]; Wijewickrema and Petras [23]). The time lag between submission and final publication can be segregated into three stages. The first is the review stage, which is the period from the receipt of the manuscript to its acceptance. The second stage is the time spent editing the accepted manuscript. The third stage is the period after this, until the article is published. The duration of the third stage can be reduced by releasing articles online ahead of their publication in print. In fact, leading publishers provide access to articles in electronic format ahead of print, which is called “article in press” (Elsevier), “online first” (Sage and Springer Nature), “latest articles” (Taylor & Francis), and “early view” (Wiley). Tort et al. [21] revealed that the average time lag between articles' online

release and the publication in print increased from 2003 to 2011. Heneberg [13] found that the time lag ranged from 0.07 to 0.34 years in 2010–2011. Lin [14] reported that although the average time lag for energy journals was 107 days, 317 out of 23,073 articles (1.37%) were published in print over 12 months after their online release.

Previous studies on the time lag between the online release and printed version focused on the effect of the time lag on immediacy index, which is defined as the number of citations received by articles in the publication year divided by the number of articles published in that year (Al and Soydal [1]; Echeverria et al. [9]; González-Betancor and Dorta-González [12]; Heneberg [13]; Lin [14]; Tort et al. [21]). However, few studies have investigated access patterns, including the influence of issuing a printed version on the electronic access to articles. Such studies are predominantly observed in the entertainment industry where sales patterns are empirically investigated for music CDs, novels, and movies (Asai [2, 3] and De Vany and Walls [8]). Additionally, Deleersnyder et al. [7] examined the relationship between electronic distribution and print publication of newspapers.

For the access patterns of journal articles, Moed [16] investigated the monthly number of article downloads in a chemical journal titled *Tetrahedron Letters* using the negative exponential function, concluding that the downloads decreased immediately after the release. Schloegl and Gorraiz [19] revealed that the number of downloads from oncology journals was concentrated immediately after the online release of the articles, which was similar to the sales patterns of music CDs and printed novels (Asai [2, 3]). Davis [5] also reported that the number of downloads of biomedical articles decreased exponentially over a year. The number of studies on patterns of access to articles is small; additionally, the target discipline is biased toward the natural sciences, such as chemistry and biomedicine.

The patterns of electronic access to articles may be influenced by factors other than print issue. Wang et al. [22] found that the number of downloads of open access articles

in *Nature Communications* was greater than that of non-open access articles, noting that the advantage of open access has persisted for a long time. Moreover, Ortega [18] found that tweets and blog mentions influenced the number of article readers. Dehdarirad [6] revealed that the early number of tweets related to an article predicted its later number of citations. Giustini et al. [11] found a positive relationship between Altmetric scores and article views. However, although Erdt et al. [10] reviewed many studies on Altmetrics, the influence on access patterns was not investigated.

This study examined the influence of social media, represented by Altmetric scores, on the number and patterns of electronic accesses as well as the influence of print publication on electronic access. Using the number of accesses to articles in a hybrid journal, this study compared the access patterns of open and non-open access articles. In general, small and medium-sized publishers of subscription journals do not release their articles online before their publication in print. The findings of this study provide them with the information on the effectiveness of online release ahead of print.

Method

Target Journal

This study investigated the access to articles in *Scientometrics*, a hybrid journal published by Springer Nature, for the following reasons. First, the publisher provides data on the number of accesses and citations, and the Altmetric scores for individual articles; these data are available on the journal website and are updated daily. Second, it is desirable to collect newly released articles for a short period to reduce the influence of differences in release time, as Tort et al. [21] found that the time lag between the online release and the publication in print gradually expanded. *Scientometrics* is a monthly journal that published about 25 articles, excluding letter, per issue in 2020. Therefore, the necessary samples can be compiled for a short period. Third, this study aimed to analyze the access patterns of articles in the social sciences, whereas Davis [5], Moed [16], and Schloegl and

Gorraiz [19] have examined the access patterns in natural science journals. Scopus, produced by Elsevier, classified the academic area of the journal as social sciences. Fourth, as *Scientometrics* is a hybrid journal, it enables the investigation of access patterns of both open access and non-open access articles.

Data Collection

This study investigated articles released online, without an assigned volume and issue number, between December 1, 2019 and March 14, 2020. The articles included research papers, but excluded letters. The number of accesses and citations, and their Altmetric scores were counted every Thursday for 52 weeks. The journal permits authors to deposit their accepted manuscript versions into repositories 12 months after publication. As deposited articles are available from repositories, this study investigated the weekly number of accesses to the journal website for a year from release to exclude the influence of deposit into repositories. Two open access articles released during the data collection period had considerable lags (40 and 41 weeks), and the reason for this was unclear. However, no other article had such large lags before and after the sample collection period. Therefore, this study considered the two articles to be unusual and did not include them in the samples. The 75 articles selected comprised of 11 open access and 64 non-open access articles.

Variables

The cumulative number of accesses and citations, and Altmetric scores in the 52nd week were defined as the variables *Access*, *Citation*, and *Altmetric*, respectively. To examine the degree of concentration of access immediately following the articles' online release, this study calculated the proportion of the cumulative number of accesses in the second week to the cumulative accesses in the 52nd week (as a percentage) and referred to it as *Access2*. As this study counted the weekly accesses on Thursdays, some articles had

accesses for fewer than seven days in the first week. Therefore, cumulative accesses in the second week were employed to compare the concentration of demand across articles. The Altmetric score in the second week was defined as *Altmetric2*. This study measured the week in which the cumulative accesses to an article reached 50% of the total accesses and defined it as *Half*. It defined the number of weeks between articles' online release and their publication in print as *Lag*. Moreover, this study defined the number of authors in an article as *Author* to represent article characteristics. Table 1 provides the definitions of these variables.

(Table 1)

Data Description

Descriptive Statistics

Table 2 reports the distribution of the number of weeks between articles' online release and their publication in print. Out of the 75 articles, 16 (21.33%) were published in print seven weeks after their online release. Articles with lags of six to nine weeks accounted for 73.3%. There was no significant difference between the time lag for the open and non-open access articles.

(Table 2)

Table 3 reports the summary of statistics of the variables by article type. The mean of *Access* for the 11 open access articles (1,919) was significantly larger than that for the 64 non-open access articles (463). The null hypothesis that the mean of *Access* is equal for open access and non-open access articles was rejected at the 1% significance level. The same findings were applied to the median of *Access*. The results were similar to those of Davis [4] and Wang et al. [22] who found that open access increased the articles' readership.

The mean of *Access2* for the 11 open access articles was 15.72%, which was close to that of the non-open access articles (14.39%). The mean of *Half* revealed that the cumulative number of accesses reached half of the total yearly access in around 15 weeks

for both the open access and non-open access articles. The null hypothesis that the mean of *Half* is equal between the two article types was not rejected at the 10% significance level. Moreover, the median of *Half* was 14.00 for both types.

The mean of *Altmetric* for the 11 open access journals (6.64) was relatively similar to that of the 64 non-open access articles (5.75). However, the coefficients of variation were large (92.0%, 166.2%). These findings indicated that the Altmetric scores depended on individual articles rather than on whether the article was an open access or non-open access article. The means of *Altmetric2* and *Altmetric* for the 64 non-open access articles were 4.16 and 5.75, respectively, and the difference between them was small. These findings indicated that the information distribution on social media was concentrated in the early stages of the articles' release. This was consistent with the results of Ortega [18], who noted that tweets and blog mentions were early metrics with a short life cycle. However, these results did not apply to open access articles, although the samples were small.

The means of *Citation* for the open and non-open access articles (2.364, and 2.078) were similar. These results were consistent with those of Davis [4], McCabe and Snyder [15], and Müller-Langer and Watt [17] who found that the citation advantage of open access was small. The mean of *Lag* for the 11 open access articles (7.18) was similar to that for the non-open access articles (7.08). Regarding the 11 open access articles and 64 non-open access articles, the means and medians of the seven variables other than *Access* did not differ between the two types at the 10% significance level.

(Table 3)

Correlation

Table 4 presents the correlation coefficients according to article type. The relationship between the number of accesses and the Altmetric scores, and between the number of accesses and the number of citations, can be investigated using the correlation coefficients

between *Access* and *Altmetric*, and between *Access* and *Citation*. The correlation coefficients between *Access* and *Altmetric* for both open access and non-open access articles were approximately the same and positive (0.481 and 0.499, respectively). These findings implied that the articles with higher Altmetric scores were accessed more often, although this association was relatively weak. In contrast, the relationship between *Access* and *Citation* differed between the two types. The correlation coefficient for non-open access articles (0.726) was positive at the 1% significance level, indicating that the number of accesses had a significantly positive relationship with the number of citations in a year. The correlation coefficient for open access articles (0.169) was small and the null hypothesis that the figure is equal to zero was not rejected at the 10% significance level.

The correlation coefficients between *Access* and *Access2* and between *Access* and *Half* are useful for investigating the relationship between the number of accesses and access patterns. The correlation coefficients between *Access* and *Access2* for the two article types were close to zero (0.007 and 0.030, respectively), implying that the concentration of accesses in the second week did not predict the number of yearly accesses. By contrast, although the correlation coefficient between *Access* and *Half* for open access articles was small at 0.120, that for non-open access articles was positive at 0.399 at the 1% significance level. These results indicated that the articles that took a long time to reach 50% of the number of accesses were more frequently accessed.

Regarding the relationship between the Altmetric scores and other variables, the two correlation coefficients between *Altmetric2* and *Citation* for open and non-open access articles (0.184 and 0.271, respectively) were small and positive, which was consistent with the conclusion of Dehdarirad [6] that early tweet counts had a weak positive association with later citations. Giustini et al. [11] reported that the correlation coefficient between citations and page views was 0.69 and that between page views and Altmetric scores was 0.53. The two coefficients were relatively similar to the corresponding figures

for the 64 non-open access articles (0.726 and 0.499, respectively). The correlation coefficients between *Access2* and *Altmetric2* (0.544 and 0.446, respectively) for the open and non-open access articles were positive. These findings indicated that accesses to articles with large Altmetric scores were concentrated in the two weeks following their online release. The correlation coefficients between *Half* and *Altmetric2* (−0.338 and −0.109, respectively) and between *Half* and *Altmetric* (−0.130 and −0.162, respectively) for the two article types were negative. These results implied that a large Altmetric score resulted in the concentration of accesses in the early stages.

(Table 4)

Access Patterns

This study calculated the proportion of weekly accesses to total accesses for individual articles (in percentage) to identify access patterns. If the weekly number of accesses was equal across 52 weeks, the proportion would be 1.92%. Figures 1–7 illustrate the patterns of access to open and non-open access articles with lags from 4 to 10 weeks. Figure 1 displays the mean proportion of the number of weekly accesses to the total, for four non-open access articles published in print four weeks after their online release, and the proportion for one open access article that satisfied the same requirements. Although the proportions in the first and second weeks were high, the access demand immediately decreased. However, the weekly proportions, for open and non-open access articles, again increased in the fifth week (8.90% and 6.80%, respectively). Subsequently, the proportions gradually declined. The cumulative number of accesses for open and non-open access articles accounted for more than 50% in the 16th and 13th weeks, respectively. After that, the weekly proportions for the two article types remained stable at approximately 1.30%. Similarly, Figure 2 shows the mean proportion of the number of weekly accesses to the total, for six non-open access articles and two open access articles published in print five weeks following their online release. Although the mean

proportion in the first week for the non-open access articles was 6.92%, the figure declined immediately. However, it increased again to 7.39% in the sixth week. Figure 3 had the characteristics peculiar to the open access article. The weekly proportion for the open access article increased in the 34th week (October 15, 2020) and then maintained a relatively high level. As the article examined the achievement of Nobel laureates, the announcement of Nobel prizes may have increased the readership between October and December.

In Figure 4, the cumulative number of accesses to non-open access articles accounted for more than 50% in the 13th week. During the period between the 13th and the 52nd weeks, the number of weekly accesses was stable around the mean (1.31%). In Figure 5, the cumulative number of accesses in the first and second weeks for nine non-open access and three open access articles accounted for 18.1% and 23.3%, respectively, indicating that demand was concentrated immediately following online release. In Figure 6, the mean cumulative proportion of accesses in the first and second weeks for two open access articles was 15.9%, while that for 11 non-open access articles was 11.5%. After the two weekly proportions declined immediately, they were over 8.0% in the 10th week. Figure 7 shows that although access to an open access article was not concentrated immediately following online release, the weekly number increased significantly one week after print publication.

The seven figures show similar trends and a brief summary of these illustrations is presented here. First, access to articles was concentrated immediately after their online release. The initial demand for articles in *Scientometrics* may reflect the activities of researchers who are strongly committed to this journal. Second, the demand for an article declined after the second week following the online release. This could be because newly released articles are placed at the top of the web page for online released articles, without an assigned volume and issue numbers. These move to the bottom of the front page or to the next page within several days, as new articles are uploaded on the web page.

Consequently, the articles released several days ago would be less noticeable. Third, the number of electronic accesses increased when the articles were published in print and subsequently, a relatively large number of accesses were made for several weeks. Fourth, the number of weekly accesses remained almost constant after the cumulative number of accesses reached half of the total accesses. Whereas Davis [5], Moed [16] and Schloegl and Gorraiz [19] revealed that the number of downloads of articles in natural science journals decreased exponentially, these findings did not apply to the yearly access patterns of this journal. Fifth, although the increased access to open access articles continued for a year, the weekly proportion did not differ significantly between open and non-open access articles. Open access did not influence access patterns, although it increased the number of accesses.

(Figures 1–7)

Discussion

It has been hypothesized that publications using two formats decrease the demand for each format (Deleersnyder et al. [7]). However, the present study found that electronic access increased when articles were printed, most likely because leading journals, such as Springer Nature, send an e-mail to announce the publication of a new issue to people who sign up for alerts. Subscribers receiving this information learn about new issues and are likely to access the journal online to read the electronic version of the article. This perhaps results in the increase of online access at the time of print publication. One other reason could be that researchers access the articles again to obtain the volume and issue numbers to complete the reference list in their articles.

The number of articles published has been increasing every year, according to the Web of Science, an abstract and citation database produced by Clarivate. It has become crucial for publishers to raise awareness about their journals and articles. Distributing articles in two formats is an effective way to achieve this. Moreover, the positive

correlation coefficients between *Access* and *Altmetric* indicate that social media, such as tweets, can increase readership. It may be effective for publishers to announce new issues via social media.

Although distributing the same content twice may be burdensome for publishers, releasing articles online ahead of print publication not only distributes research work quickly, but also provides publishers with opportunities to increase site traffic. Therefore, releasing articles online ahead of print publication may be worth consideration for small and medium-sized publishers.

Conclusion

This study investigated access patterns using the weekly number of accesses in a hybrid journal in the social sciences. One of the main findings was that the release of an issue in print format increased articles' electronic access. The results indicated the benefits of utilizing two publication formats. While open access increased the total number of accesses, it was the Altmetric scores that significantly influenced access patterns. Moreover, the number of accesses up to 15 weeks generally exceeded half of the total yearly access, but the weekly number remained stable thereafter. These results indicate that the access patterns in *Scientometrics* differ from those in the natural science journals presented in previous studies. Publishers may need different marketing strategies according to the disciplines of the journals.

This study investigated the access to articles in *Scientometrics* only. In particular, the number of open access articles was small, as most authors did not choose to publish in this format. Therefore, the results cannot be generalized to other social science journals. However, by investigating many journals, differences in the access patterns across the journals in social sciences and in several academic areas can be examined. Additionally, future studies could help determine the appropriate embargo period by examining the access patterns for a few years.

Acknowledgements

This work was supported by the Japan Society for the Promotion of Science, KAKENHI (grant number 20K01663).

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Table 1. Definition of variables

<i>Access</i>	the cumulative number of accesses in the 52nd week
<i>Altmetric</i>	the Altmetric score in the 52nd week
<i>Citation</i>	the cumulative number of citations in the 52nd week
<i>Access2</i>	the proportion of the cumulative number of accesses in the second week to total access, measured as percentages
<i>Half</i>	the week in which the cumulative access to an article reached 50% of the total access in the 52nd week
<i>Altmetric2</i>	the Altmetric score in the second week
<i>Lag</i>	the number of weeks between the articles' online release and printed publication
<i>Author</i>	the number of authors for an article

Table 2. Time lag (weeks)

Time lag (weeks)	Number of titles
3	1 (0) 1.33%
4	5 (1) 6.67%
5	8 (2) 10.67%
6	14 (1) 18.67%
7	16 (1) 21.33%
8	12 (3) 16.00%
9	13 (2) 17.33%
10	6 (1) 8.00%
Total	75 (11) 100%

Note. The number of open access articles are presented in parentheses.

Table 3. Summary of statistics

	Open access articles N = 11						
	<i>Access</i>	<i>Altmetric</i>	<i>Citation</i>	<i>Access2 Half</i>	<i>Altmetric2 Lag</i>	<i>Author</i>	
Mean	1,919***	6.64	2.364	15.72	15.27	2.36	7.18 2.45
Median	1,876***	4.00	2.000	18.28	14.00	1.00	8.00 2.00
SD	796	6.10	3.010	8.82	6.03	2.80	1.94 1.57
CV %	41.50	92.0	127.3	56.11	39.51	118.6	27.01 64.06
	Non-open access articles N = 64						
	<i>Access</i>	<i>Altmetric</i>	<i>Citation</i>	<i>Access2 Half</i>	<i>Altmetric2 Lag</i>	<i>Author</i>	
Mean	463	5.75	2.078	14.39	14.95	4.16	7.08 2.813
Median	386	1.00	1.000	12.49	14.00	0.00	7.00 3.000
SD	303	9.56	2.86	7.85	4.88	8.49	1.72 1.402
CV %	65.49	166.2	137.5	54.52	32.62	204.4	24.32 49.83

SD: standard deviation

CV: coefficient of variation

*** denote significance at the 1% level

Table 4. Correlation coefficients

	Open access articles N=11							
	<i>Access</i>	<i>Altmetric</i>	<i>Citation</i>	<i>Access2</i>	<i>Half</i>	<i>Altmetric2</i>	<i>Lag</i>	<i>Author</i>
<i>Access</i>	1.000							
<i>Altmetric</i>	0.481	1.000						
<i>Citation</i>	0.169	0.209	1.000					
<i>Access2</i>	0.007	0.478	-0.102	1.000				
<i>Half</i>	0.120	-0.130	0.121	-0.832***	1.000			
<i>Altmetric2</i>	0.199	0.745***	0.184	0.544*	-0.338	1.000		
<i>Lag</i>	-0.107	0.015	0.210	0.075	-0.269	0.023	1.000	
<i>Author</i>	-0.207	-0.658**	0.152	-0.495	0.080	-0.450	0.560*	1.000
	Non-open access articles N=64							
	<i>Access</i>	<i>Altmetric</i>	<i>Citation</i>	<i>Access2</i>	<i>Half</i>	<i>Altmetric2</i>	<i>Lag</i>	<i>Author</i>
<i>Access</i>	1.000							
<i>Altmetric</i>	0.499***	1.000						
<i>Citation</i>	0.726***	0.322***	1.000					
<i>Access2</i>	0.030	0.424***	-0.189	1.000				
<i>Half</i>	0.399***	-0.162	0.439***	-0.570***	1.000			
<i>Altmetric2</i>	0.504***	0.888***	0.271**	0.446***	-0.109	1.000		
<i>Lag</i>	-0.066	-0.057	-0.256**	0.003	-0.013	-0.118	1.000	
<i>Author</i>	-0.008	-0.005	0.047	-0.071	0.064	-0.087	-0.244	1.000

***, ** and * denote significance at the 1%, 5% and 10% levels

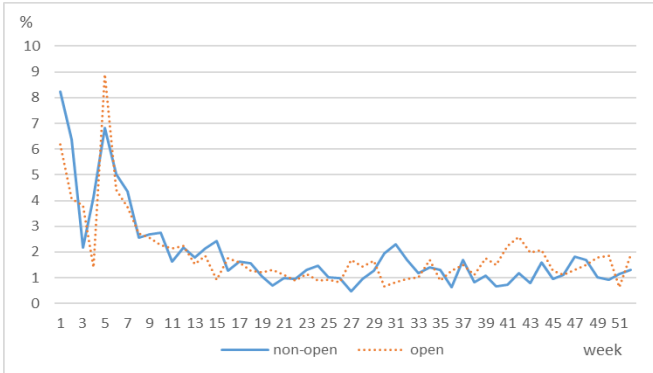


Figure 1. Weekly accesses to articles with a lag of four weeks

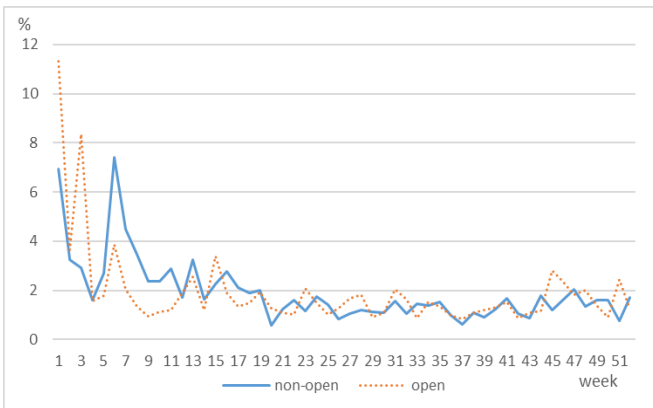


Figure 2. Weekly accesses to articles with a lag of five weeks

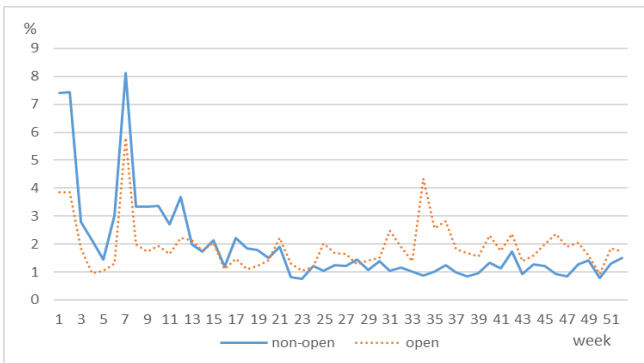


Figure 3. Weekly accesses to articles with a lag of six weeks

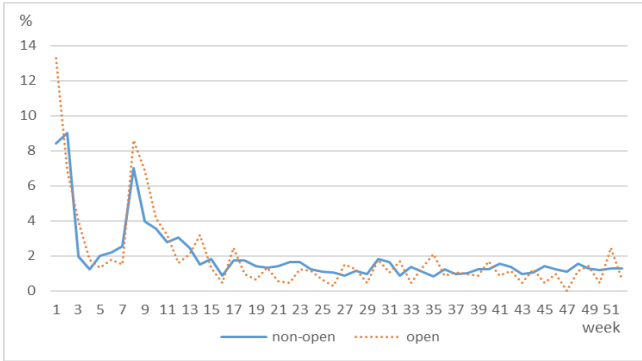


Figure 4. Weekly accesses to articles with a lag of seven weeks

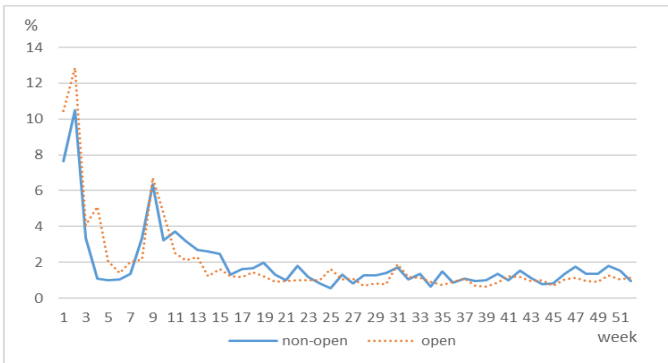


Figure 5. Weekly accesses to articles with a lag of eight weeks

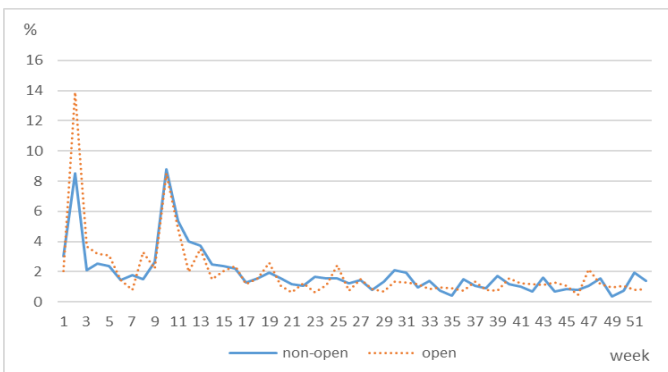


Figure 6. Weekly accesses to articles with a lag of nine weeks

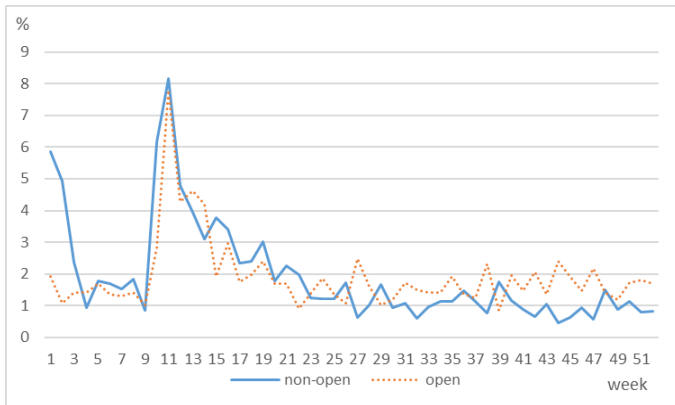


Figure 7. Weekly accesses to articles with a lag of ten weeks