

The Dispersion Phenomenon of Journal Citations in a Digital Environment*

디지털 환경에서 학술지 인용의 분산화 현상에 관한 연구

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ABSTRACT

Electronic publishing has influenced, and in some ways changed, information seeking, reading patterns and citation behaviours. This study collected the Cited Half-Lives, the indicator implies the life-span of scholarly journals, from *JCR Social Science* edition the before and after of the prevalence of electronic journals, and observed if there are some changes in these two periods. The analysis results of eight disciplines show that the average Cited Half-Lives increased in 2007 than in 1994 for seven disciplines except the demography. Especially in the four disciplines of economics, education, finance and sociology, the average Cited Half-Lives increased significantly. This results show that the concentration, researchers cite more recent articles and concentrate their citations on fewer ones, is lightening and the dispersion of citations is actually increasing. With the online availability of articles and journals the old online materials can be often accessed, used and cited more frequently, the more growth potential of Cited Half-Lives are made in a digital environment. Further research needs to investigate if the phenomenon will become more obvious in various disciplines after a few years.

초 록

전자출판은 정보검색, 이용패턴, 인용행태 등 학술 커뮤니케이션 전반에 많은 영향을 주었고 변화를 초래하였다. 이 연구는 전자출판 특히 전자학술지의 보급이 학술 커뮤니케이션에 어떠한 영향을 미치고 있는지를 규명하기 위하여 학술지의 수명을 간접적으로 보여주는 지표라 할 수 있는 인용반감기 데이터를 JCR 사회과학 편으로부터 수집한 후 전자학술지 도입 이전과 이후를 비교하고 분석하였다. 모두 여덟 분야의 주제영역에 관하여 데이터를 분석한 결과 인구통계학을 제외한 일곱 부문에서 1994년에 비해 2007년의 인용반감기가 증가한 것으로 나타났다. 특히 경제학, 교육학, 재정학, 사회학 등의 네 주제영역에서는 인용반감기의 평균이 통계적으로 유의미하게 증가하였다. 이 결과는 과거와 같이 핵심 학술지 및 최신호에 이용이 집중되던 현상이 완화되고 비핵심 학술지 및 오래된 학술지의 이용이 상대적으로 증가하는 '학술지 인용의 분산화(탈집중화) 현상'이 나타나기 시작했다는 것을 보여주는 것으로 간주할 수 있을 것이다. 디지털 환경에서는 오래된 자료라도 여러 가지 미디어에 힘입어 원활하게 접근이 가능하기 때문에 이의 이용과 인용이 증가할 가능성이 있고, 따라서 인용반감기의 증가로 이어질 수 있는 가능성도 충분하기 때문이다. 그러나 이러한 현상이 일시적으로 나타난 것인지 아니면 매우 다양한 분야에서 지속적으로 나타날 것인지는 시간을 두고 더 관찰해야 할 것으로 보인다.

Keywords: Cited Half-Life, dispersion phenomenon, journal, usage, citation, life span
인용반감기, 분산화현상, 학술지, 이용, 인용, 수명

* This work was supported by the Korea Research Foundation Grant funded by the Korean Government (KRF-2008-327-H00018).

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▪ Received : 28 May 2009 ▪ Revised : 4 June 2009 ▪ Accepted : 10 June 2009

▪ Journal of the Korean Society for Information Management, 26(2): 211-222, 2009.

[DOI:10.3743/KOSIM.2009.26.2.211]

1. Introduction

Generally users enjoy reading core scholarly journals over peripheral ones, and they pursue current issues within a few years following the publication. For the purpose of satisfying such users' needs, many libraries have subscribed to the core scholarly journals which readers prefer understanding of current issues related to the field. This resembles with the Pareto Principle in the marketing field which 20% of a population or group can explain 80% of an effect, such as productivity, and this is the golden rule which is accepted for a long time (Eldredge 1998). Fleming and Kilgour found that 28% of the journal titles at two academic health libraries accounted for 80% of the overall journal use (Fleming and Kilgour 1964).

But in the digital era, users prefer searching scholarly information through the Internet and downloading the full texts to visiting themselves at libraries. In the past, users were supplied the scholarly information by the latest publication year, but in recent years they very often obtain the information by relevance rankings in libraries' search platforms or other search engines. Such a relevance ranking display is ready to stop covering old articles with new ones and disappearing old ones from users' sights. Therefore nowadays users can often access older articles as well as recent ones, and the old materials can be used and cited more frequently than before.

The prevalence of the electronic publications leads for researchers to access the latest materials

more easily than the past, even to take available forthcoming articles published ahead of print. But it should be noted that researchers are not inclined towards recent materials but they often use and cite old ones more and more, even though digital environments help them to get instantly newest materials. Although the newest materials were published excessively, the old materials which were rolled back long ago are attracting users' attentions again and are used and cited actively.

This study is interested in the dispersion phenomenon appears in scholarly journal usage, especially journal citation. The study gathered the Cited Half-Lives and analysed if the numerical values were increased as time goes by. As digital media are becoming more influential, the uses and citations of old articles are increasing. The more use of old articles are arisen, the more growth potential of Cited Half-Lives are made. The continuous growth of Cited Half-Lives might imply the dispersion phenomenon appearing in the field of scholarly journals.

1.1 Aims and Objectives

Since the beginning of electronic age, the scholarly communication environment has changed remarkably. Through the gathering and analysing the data of scholars' usage of academic journals this study tried to grasp if there are some concrete changes of scholarly communication, especially the life span of the academic journals. The life span of the academic journals can be observed by collec-

ting the use or citation number within a given period. This study collected and analysed the Cited Half-Lives, an indicator signifies the life-span of academic journals, from *JCR* on behalf of exact use or citation number. Because it can be assumed that the Cited Half-Lives are enough to show several major transitions with the passage of time. There are great differences in the longevities of academic journals depending on subject categories, and they can be affected by media types. The objective of this study is to understand whether there are some alterations of Cited Half-Lives before the adoption of electronic media and after it.

Before the analysis it is necessary to review previous related studies to examine what kind of factors may impact on Cited Half-Lives. Tsay described that most journals with longest Cited Half-Lives have several special features (Tsay 1998). It seems likely that they are published frequently. In other words, the publications that are published monthly or bi-monthly could be accumulated longer than other journals in libraries. The older preserved journals the libraries have, the higher citation is expected. Almost all the long lived journals are published in English, and multi-language journals are usually cited for a longer time. Co-edition journals are less obsolescent. So, four factors -- frequency, history, language and publishing country -- could affect a long Cited Half-Lives. This paper takes an interest in that availability of electronic journals or online separate articles could exert influence to the Cited Half-Lives of academic journals in addition to these four factors.

This paper is to investigate if there are any shifts of the time span of journal usages by observing the change of the Cited Half-Lives longitudinally. The results are expected to help in modifying and complementing the service policies of academic libraries or publishers. If the number of old article citations decreased steadily, not rapidly with the passage of time, old publications can be regarded to keep the value for a long time contrary to popular belief. That is to say, if the old articles are in decay at a slow speed and the dispersion phenomenon appears in the journal article usage, the traditional service policies of academic libraries or publishers need to be soften and supplemented. They should supply harmoniously not only recent materials but also old ones that are ignored under the excuse of lacking collection space. What is more, it is necessary to upgrade the search platforms to access old articles quite easily, because users seem to take pleasure in reading old publications repeatedly.

2. Literature Review

Even there may be some differences under the subject categories, scholars prefer reading the recent papers in order to develop the research ideas and take proper scientific methodologies in general. However, scholars are not only concerned about the recent papers, they are also giving a great valuation of the old ones and using it successively (King and Tenopir 1999; Tenopir and King 2000;

Tenopir and et. al. 2005).

Tenopir and King analysed the age distribution of the articles for formal publication used by faculty users, the result was that recent papers took 26% and the older ones kept 42% (Tenopir and King 2000). And the time required for reading showed that faculty users costed 35 minutes to read the papers published within one year, 49 minutes for publications printed over one year, and 53 minutes for materials published more than five years. This means that the older publications required more time for reading. Tenopir and others described that 25% of articles were reread by astronomer and older ones could be reread for many times in the field. Because the value of the publications kept for a long time and these older ones could be supplied by online versions in the field (Tenopir and et. al. 2005).

Odlyzko showed many people considered the use of journals to be reducing after being published as time goes by, but as journals or separate articles are offered via electronic versions the using frequency of the older ones could be increased (Odlyzko 2002). For example, all issues of an online peer reviewed journal *First Monday* had been published in 1997 were downloaded with 9,064 times in 1999 while they were done with 19,378 times in 2000. Therefore in the electronic publications days people do not drift with current issues only, but they use and cite latest articles and old ones in balance. And after analysing the usage of journals published by Elsevier, Laarhoven and Fahmi showed that half of the most used articles were published less than five years ago (Laarhoven and Fahmi 2005).

Several scientists claim that famous publications could be called “the citation classics” in the field are not latest publications but old ones repeatedly cited for a long time (Odlyzko 2002; Guthrie 2000; Herman 2004a; Herman 2004b; Garfield 2009). The convenience to access electronic versions have a great effect on the revitalization of old publications, and the spread of online abstracts or indexes also is making a rise of citation of old copies.

On the other side, some studies show that the age distribution of used articles was very different according to the method of scientists’ searches (Nicholas and et. al. 2005; Huntington and et. al. 2006). Nicholas and others found that the recent information search platforms can display the results sorted not only by publishing year but also by relevance (Nicholas and et. al. 2005). In the latter situation, no matter what latest article or old article, there are the same chances to be chosen. Therefore, there is a strong possibility that old articles could be get by readers than the past.

Starr and Williams described that the number of requests received decreased with age of publication using analysis of usage of a major Biomedical library’s pre-1993 print journal collection. But they found out the usage distribution revealed a “long tail” with keeping value for long time (Starr and Williams 2008).

Tenopir and others explained that the amount of readings per reader is rising and the old articles number is increasing since they could be searched online. The possibility of reading old online articles is growing rapidly because online back-files of

journals are prevailed recently. The proportion of reading by scientists from browsing reduced in these days, replaced by other meanings such as auto searching, colleagues, citations and so on. In other words, a great part of recent articles could be found by browsing (74.5%), but old articles could be examined by citations (46.9%) or searching (32.8%) (Tenopir and et. al. 2009).

Lariviere and others asserted that the dispersion of citations is obviously increasing, after they analysed changes in the concentration of citations received by papers published between 1900 and 2005 (Lariviere and et. al. 2009).

3. Data Collection

The Cited Half-Lives means the number of publication years from the current *JCR* year that account for 50% of citations received by the journal. This study made a collection of the Cited Half-Lives from *JCR*.

The Cited Half-Lives of scientific journals varies with disciplines; therefore, the value of Cited Half-Lives will be different depends on what discipline someone choose. This study is focusing on identifying that availability of digital full texts including electronic journals, online back-files, e-prints servers, separated copies offered by author's websites, might impact on the use of old

articles successively.

In 2000, Guthrie analysed the usage data for fifteen disciplines of *JSTOR*, his study referred by this research (Guthrie 2000). This research selected the subject disciplines supplied by *JCR* Social Science edition accord with Guthrie's disciplines. In detail, this research collected Cited Half-Lives falling on eight subject disciplines including anthropology, and classifying the data into three periods separately owing to level of electronic journals diffusions: non-adoption for electronic journals period, early adoption for electronic journals period, and popularization for electronic journals period. The 1994 Cited Half-Lives stand for non-adoption for electronic journals period; 2001 year sit for early adoption for electronic journals period; 2007 year act for popularization for electronic journals period.

The results show that assembled Cited Half-Lives is not numerous compared to other indicators such as Impact Factors and Immediacy Index. Table 1 display the numbers of journals contain Cited Half-Lives matched more than one year among three specific years. The journal numbers were great different in subject categories. In contrast to the year 1994, the journal numbers increased in the year 2001 and 2007. And if the Cited Half-Life numbers were over ten years, they were treated as ten years because it was impossible to get the exact data from *JCR*.

〈Table 1〉 Numbers of Cited Half-Lives classified with disciplines and years

Disciplines	Number of titles		
	1994	2001	2007
Anthropology	24	44	43
Demography	10	13	14
Economics	82	137	136
Education	66	90	87
Finance	23	30	30
History	28	41	43
Political Science	29	52	52
Sociology	45	71	770
Total	307	478	475

4. Results

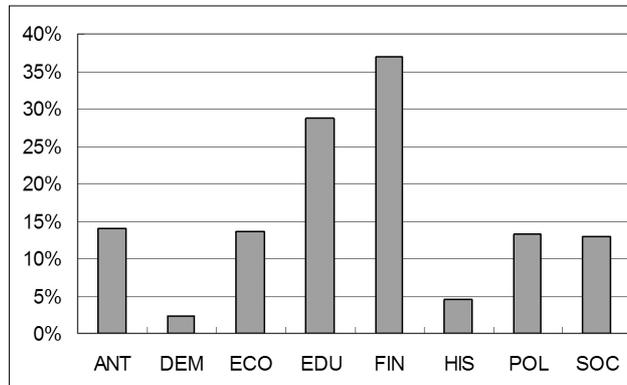
Table 2 indicates the average Cited Half-Lives was steady in demography for all years. On the other side, every Cited Half-Lives except for demography increased with time. That is the Cited Half-Lives of 2007 increased comparing to 1994 for the seven subject categories. But according to the ANOVA analysis, only four categories including economics, education, finance and sociology, had the differences of an average Cited Half-Lives with significance as time goes by

($p < 0.01$). But average Cited Half-Lives in the other three categories did not rise significantly for three points of time.

After contrasting the year 2007 with 1994, there are diverse increasing rates of the average Cited Half-Lives shown in Figure 1. Most remarkable is that average Cited Half-Lives for finance field went up from 6.5(1994) to 8.9(2007) at 36.9 per cent. That is, the total citations of old articles for the field were more in 2007 than in 1994, and it could be causative of the rising Cited Half-Lives. Table 3 shows the frequency table of Cited

〈Table 2〉 Comparison of average Cited Half-Lives over time

Disciplines	Average Cited Half-Lives			<i>p</i>
	1994	2001	2007	
Anthropology	7.9	8.7	9.0	0.05
Demography	8.2	8.0	8.4	0.84
Economics	7.3	7.6	8.3	0.00
Education	6.6	7.9	8.5	0.00
Finance	6.5	7.5	8.9	0.00
History	8.9	9.2	9.3	0.52
Political Science	6.8	7.1	7.7	0.07
Sociology	7.8	8.4	8.8	0.00



<Figure 1> Increasing rates of Cited Half-Lives comparing 2007 with 1994

<Table 3> Frequency distributions of Cited Half-Lives classified with age intervals in 1994

Disciplines	Journal Cited Half-Lives					
	0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-10	>10
Anthropology		2	2	7	6	7
Demography			1	4	4	1
Economics		4	18	23	23	14
Education		3	22	23	14	4
Finance		2	7	10	4	
History			3	3	8	14
Political Science	1	3	5	10	8	2
Sociology			12	10	10	13

<Table 4> Frequency distributions of Cited Half-Lives classified with age intervals in 2007

Disciplines	Journal Cited Half-Lives					
	0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-10	>10
Anthropology			3	8	5	27
Demography				6	2	6
Economics			14	38	36	48
Education		1	5	22	32	27
Finance			2	4	12	12
History			2	6	6	29
Political Science		1	8	21	10	12
Sociology			2	17	24	27

Half-Lives with age intervals in 1994, while Table 4 displays the frequency table of Cited Half-Lives with age intervals in 2007. Comparing Table 4

with Table 3, the journal numbers grew in the section of higher age in 2007 than the year 1994. Especially in the case of ‘Cited Half-Lives>10’

the growth of journal number is obvious in 2007 in comparison with 2004, even if their frequencies for age intervals varies with the academic fields. For example, for history field the number of 'Cited Half-Lives>10' is fourteen in 1994, but it went on increasing to twenty nine in 2007 as much again. But the number of 'Cited Half-Lives>10' escalated from zero in 1994 to twelve in 2007 for finance field. It means that the number in 2007 is more ten times than in 1994.

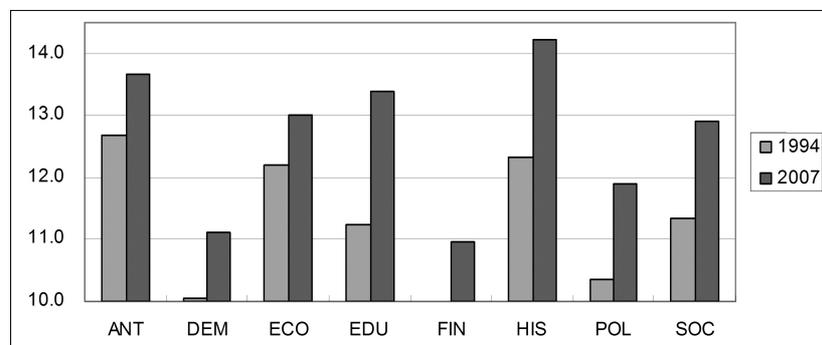
If the number of Cited Half-Lives are over ten years, *JCR* always report 'Cited Half-Life>10' without specific number. For identifying the accurate number, the estimated value of the Cited Half-Lives has been calculated in this study. Thus, the Cited Half-Life values presumed per every journal by performing the regression analysis that had used the cited cumulative percent of the last ten years. Figure 2 displays various increasing rates of estimated Cited Half-Lives comparing 2007 with 1994 under disciplines.

The estimation of the average Cited Half-Lives greater than ten years varies directly as subject

fields shown in Figure 2. For finance and history, the estimation values of the Cited Half-Lives incremented obviously in 2007 comparing to the year 1994. In finance, the journal number increased from zero to twelve between 1994 and 2007, and the average estimated longevity was no more than eleven years. On the other hand, the value is fourteen years in the history, and there were no less than three titles that their estimated Cited Half - Lives are more than 20 years.

5. Discussion

In 2000 Guthrie collected the top ten most used articles from *JSTOR*, as it is called the old articles' digital treasuries, and analysed the average age (Guthrie 2000). Comparing Guthrie's analysis to this study, his average age is higher than these for five disciplines out of eight. For example in economics, *JSTOR*'s average age of top ten articles is over thirteen years while the average Cited Half-Life in this paper is below nine years. That



<Figure 2> Average estimations for Cited Half-Lives greater than ten years

JSTOR calculated the average usage age with the back-files of old issues excluding current issues caused their age to be risen. However, that *JSTOR*'s usage frequencies were heavily over time described in Guthrie's paper. And in this paper the citation of old articles rose and the Cited Half-Lives expanded longer for some disciplines in process of time. Thus, the result of this paper is similar to Guthrie's analysis in which use or citation of old articles has risen year by year.

Tenopir and others found that in the 70s, 80s and 90s the reading of papers published within one year was consistent at about two-thirds of all readings, while old papers took about one-thirds of all readings (Tenopir and et. al. 2009). In these days the recent papers and the old ones are read almost equally. There are a variety of reasons to explain the growth of old papers usage in the proportion of readings. This trend may be caused by the improving access to electronic journals; the expansion of separate online articles be published on authors' own websites; the increment of e-prints servers give the access to pre-prints and the spread of relevance ranking search engines which supplies same or unbiased chances both recent and old articles to be read. In some ways, this study is analogous to Tenopir and others' study; that is, they found that the utilizations of old articles are continuing to be increased. In this study, it has been clarified that the average of Cited Half-Lives incremented in significance for four subject categories including economics, education, finance and sociology in 2007 than in 1994. As the publishing system

switches almost the whole to electronic environments, many academic journals have turned into long Cited Half-Lives and they seems to have some special natures. In order to identify the natures this study added the detailed analysis for economic journals, so economics has the most journals of all eight sample subject categories.

In 2007, there were forty eight economic journals with a Cited Half-Life over ten years, and all of them were refereed journals. All the journals supplied with both print and electronic forms but not with open access. Also, all the titles offered electronic back-files and twenty nine titles of them were supplied by *JSTOR*. By checking out the publishing countries, it found that 26(54%) were from U.S., 13(27%) from Britain, 5(10%) from Netherlands and 4(9%) from other countries. *Journal of Institutional and Theoretical Economics* started in 1844, so it is the oldest journal with a 165-year history. On the other side *Journal of the Japanese and International Economics* was founded in 1987 and is only 22 years old, but it belongs to the group of journals with Cited Half-Life greater than ten years. Most of the titles published in English (46, 96%), and then again only two journals were published in Dutch. Almost half of them were published quarterly, and three journals (6%) were issued monthly. They were provided with document supply service including BLDSC, CISTI and etc., so there were enough to document availability.

6. Conclusion

After collecting and analysing Cited Half-Lives of eight disciplines, this study found out that the average Cited Half-Lives in 2007 was higher than 1994 for seven disciplines. And for four disciplines the differences between 1994 and 2007 are statistically significant. The time span of scientific journals has been prolonged in the four disciplines, such a new trend that citations of old articles were equivalent roughly to citations of recent ones was perceived indirectly. Unlike the past, a leaning towards recent articles has been weakening year by year, and this might imply that the dispersion phenomenon already started in scientific journals.

Tsay examined that there were several causes could affect the Cited Half-Lives, that is publication frequency, journal age, language, country of publication, and subject category (Tsay 1998). This study dealt with availability of materials also could be a major cause for making of Cited Half-Lives. Because researchers usually have not much time, they will be ready to obtain more easily access material with digital availability than print form. So many researchers are most likely to search, use, and cite the online materials irrespective of publication date, recent articles or old articles. In

the digital age, online materials are not only a great contribution to increase the availability of old articles, but also accelerate readers' uses and citation behaviours of them (Guthrie 2000; Tenopir and et. al. 2009).

When scholars use the search engines, there can be often more old articles displayed ahead of new one. So many search engines provide results ranking with relevance as well as publishing years. As the online full texts spread out and the relevance rankings are adopted extensively, old articles could be kept within scholars' sights and the old materials have also a higher visibility than before. Therefore, in spite of new-article explosion, the visibility of old materials with electronic access could be a great power to extend a life of the articles.

But it is necessary to be patient to observe if the trend in which scholars often read old articles as well as current ones will be sustainable or not. Although recent average Cited Half-Lives was greater than past for several fields in this study, it is desirable to analysis further for more other subject categories. Tsay described that Cited Half-Lives were not in keeping with Used Half-Lives, so additional research results in relation to this paper or Tsay's study might be useful better in planning library policies (Tsay 1998).

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