Jointly published by Akadémiai Kiadó, Budapest
and Kluwer Academic Publishers, Dordrecht

Scientometrics,
Vol. 60, No. 2 (2004) 121–129

The universal expression of periodical average publication delay at steady state

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The steady state solution of differential equations of periodical publication process is deduced, and based on this, the indicator of periodical publication delay, which reflects the degree of information ageing in editorial board of a periodical, is established. The indicator is proved to be the sum of two items: the pure publication delay, which reflects the editing rapidity of a periodical, and the ratio of deposited contribution quantity to the publishing quantity in one year, which reflects the waiting period of adopted papers deposited in editorial board. As a demonstration, the delay indicators of seven periodicals are calculated. Finally, the application of this indicator is discussed.

The model of periodical literature publishing process at steady state

For most periodicals, the steady state of publishing process, which refers to the state of dynamic equilibrium of accepting and publishing, is a typical state, so, Steady State Assumption is usually adopted in the research of publishing process for simplification.

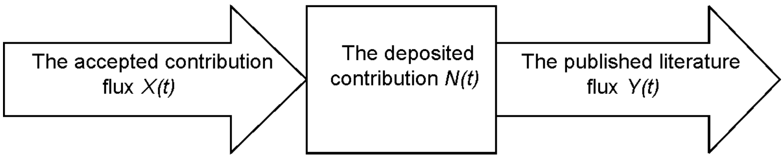

Figure 1. The physical model of the publishing process

Steady state has been widely used to describe the equilibrium state of dynamic process in the engineering and technical literature (FANG, XIAO, 1988). The literature publishing process can be taken as a continuous dynamic process (see Figure 1).

Received January 12, 2004

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0138–9130/2004/US $ 20.00

It is proved that the Steady State Hypothesis is suited for most of the processes by modeling the process and research of some examples (YU et al., 1997, 2000).

The dynamic periodical publishing process can be described by some relative factors defined by YU et al. (2000) in Table 1. The mathematical relationships among these factors have been found and the theoretical models (a continuous model and a discrete model) of the process has been established by YU et al. (2000). We can study the relationships between these factors and the internal mechanism of the process at steady state and obtain some methods to quantitatively control publication delay, which was defined in these papers (LUWEL & MOED, 1998; YU & YU, 1997).

Table 1. The relative factors of the periodical literature publishing process

Symbol	Name and concept	Dimension
T	the literature age(the age of deposited contribution); note: when the article is received , T is counted as 0	t
t	time variable	t
$X(t)$	the accepted contribution flux	pieces/t
τ	the pure time delay caused by the review of contribution	t
$N(t)$	the deposited contribution quantity	pieces
$n(T,t)$	the age distribution of the deposited contribution	pieces/t
$Y(t)$	the published literature flux	pieces/t
$Y(T,t)$	the age distribution of the published literature flux	pieces/t^2
$P(T,t)$	the age distribution of the literature publishing probability	
$\overline{T}$	the average publication delay	t

Because the continuous model is suitable for the theoretical analysis, we select the continuous model-a group of partial differential equations to deduce the universal expression of the process at steady state. It is

$$\begin{cases} \dfrac{dN(t)}{dt} = X(t) - Y(t) \\ N(t) = \int_{\tau}^{\infty} n(T,t)dT \\ Y(t) = \int_{\tau}^{\infty} y(T,t)dT \\ \dfrac{\partial n(T,t)}{\partial T} + \dfrac{\partial n(T,t)}{\partial t} = -y(T,t) \\ y(T,t) = P(T,t) \cdot n(T,t) \\ n(\tau,t) = X(t) \end{cases} \tag{1}$$

The steady state of the process is described as following: a periodical is issued, its various parameters will tend to a dynamic equilibrium state after some time, at the state the adopted contribution flux is a constant and equals to the published literature flux, the deposited contribution quantity is a constant, all factors don't change with time, so $n(T,t) = n(T)$, $y(T,t) = y(T)$, $P(T,t) = P(T)$. From Eqs 1, we have

$$\begin{cases} X = Y \\ N = \int_{\tau}^{\infty} n(T)dT \\ Y = \int_{\tau}^{\infty} y(T)dT \\ \dfrac{dn(T)}{dT} = -y(T) \\ y(T) = P(T) \cdot n(T) \\ \text{The boundary condition : } n(\tau) = X \end{cases} \tag{2}$$

Based on this model, YU et al.(1997, 2000) demonstrated the effectiveness of the model on illustrating the physical essence of the literature publishing process by finding the particular steady state solution, which is deduced under the particular condition – the age distribution of the literature publishing probability is a constant. But, in fact, the publishing probability always changes with the literature age, so the particular solution has no universality. Therefore the universal expression of the process should be deduced at steady state, internal mechanism of the process could be comprehended. According to this, a measuring indicator of periodical publishing process can be established; some quantitative methods to reduce periodical publication delay will be presented.

The steady state solution of periodical publishing process

According to the boundary condition and characteristics of the Eqs 2: $n(\tau)=X$, when $0 \le T \le \tau$, the age of every manuscript is less than the pure publication delay, the reviewing and revising process hasn't been finished yet, so the papers cannot be published and the deposited contribution quantity on every age is equal to the accepted contribution flux. So that,

$$\text{when } 0 \le T \le \tau, \quad \begin{cases} n(T) = X \\ y(T) = 0 \\ P(T) = 0 \end{cases} \tag{3}$$

When $T \ge \tau$, according to the Eqs 2, we have

$$\frac{dn(T)}{dT} = -P(T) \cdot n(T)$$

$$dn(T) = -P(T) \cdot n(T)dT$$

Integrated it on [0, T], and supposing Z (0<Z<T) as a middle variable of T, we have

$$\int_0^T \frac{dn(Z)}{n(Z)} dZ = \int_0^T - P(Z)dZ \tag{4}$$

When $T > \tau$, combining Eq. 3 with Eq. 4, we have

$$\int_0^T d\ln n(Z) = -\int_0^T P(Z)dZ = -\int_\tau^T P(Z)dZ$$

$$\ln n(T) = \ln n(0) - \int_\tau^T P(Z)dZ$$

$$n(T) = e^{\ln X} \cdot e^{-\int_\tau^T P(Z)dZ} = X \cdot e^{-\int_\tau^T P(Z)dZ}$$

$$n(T) = X \cdot e^{-\int_\tau^T P(Z)dZ} \tag{5}$$

According to Eqs 2 and 5, we can get the equation of $y(T)$ when $T>\tau$. Then associating with Eq. 3, we obtain

$$\begin{aligned} &When \quad 0 \le T \le \tau, \quad \begin{cases} n(T) = X \\ y(T) = 0 \\ P(T) = 0 \end{cases} \\ &When \quad T > \tau, \quad \begin{cases} n(T) = X \cdot e^{-\int_\tau^T P(Z)dZ} \\ y(T) = P(T) \cdot Y \cdot e^{-\int_\tau^T P(Z)dZ} \end{cases} \end{aligned} \tag{6}$$

Eq. 6 is the steady state solution of periodical publication process.

The expression of average publication delay at steady state

We use the average publication delay to describe characteristics of a certain periodical publishing process for establishing the equation of relationship between the publication delay and the interior factors of the periodical, and then establish the expression of average publication delay at steady state for quantitatively predicting and controlling the publication delay.

Firstly, the relationship equation of the average publication delay is defined as the arithmetic average of publication delay of all published papers. So we have

$$\overline{T} = \frac{\int_0^{\infty} T y(T) dT}{\int_0^{\infty} y(T) dT} \tag{7}$$

Combine Eq. 6 with Eq. 7, we can obtain

$$\overline{T} = \frac{\int_0^{\infty} T \cdot P(T) \cdot Y \cdot e^{-\int_{\tau}^{T} P(z)dz} dT}{\int_0^{\infty} P(T) \cdot e^{-\int_{\tau}^{T} P(z)dz} dT} \tag{8}$$

According to Eq. 3, the numerator of Eq. 8 can be predigest by subsection integral (O WEIYI, et. al., 1996) as follow:

$$\int_0^{\infty} Y \cdot T \cdot P(T) \cdot e^{-\int_{\tau}^{T} P(Z)dZ} dT = -\int_{\tau}^{\infty} T \cdot Y \cdot de^{-\int_{\tau}^{T} P(Z)dZ} - \int_0^{\tau} Y \cdot T \cdot P(T) \cdot e^{-\int_{\tau}^{T} P(Z)dZ} dT$$

$$= -Y \cdot T \cdot e^{-\int_{\tau}^{T} P(Z)dZ} \Bigg|_{\tau}^{\infty} + Y \cdot \int_{\tau}^{\infty} e^{-\int_{\tau}^{\infty} P(Z)dZ} dT - 0$$

$$= Y \cdot \tau + Y \cdot \int_{\tau}^{\infty} e^{-\int_{\tau}^{T} P(Z)dZ} dT$$

The denominator of Eq. 8 can be transformed as follows:

$$\int_0^{\infty} Y \cdot de^{-\int_{\tau}^{T} P(z)dz} = \int_0^{\infty} Y \cdot e^{-\int_0^{T} P(Z)dZ} dT = -Y \cdot e^{-\int_0^{T} P(z)dz} \Big|_0^{\infty} = Y$$

Then combining Eq. 6, we have

$$\overline{T} = \tau + \frac{\int_{\tau}^{\infty} Y \cdot e^{-\int_{\tau}^{T} P(z)dz} dT}{Y} = \tau + \frac{\int_{\tau}^{\infty} X \cdot e^{-\int_{\tau}^{T} P(z)dz} dT}{Y} = \tau + \frac{\int_{\tau}^{\infty} n(T) dT}{Y} = \tau + N/Y$$

So we obtain the universal expression of average publication delay at steady state:

$$\overline{T} = \tau + N/Y \tag{9}$$

Here, $\overline{T}$ is defined as the indicator of periodical publication delay, τ, N and Y are defined as characteristic parameters of the process at steady state. The indicator expresses the relationship between average publication delay and characteristic parameters from the process's internal mechanism, some conclusions are obviously shown as follows:

(1) The average publication delay is proved to be the sum of two items: the pure publication delay τ which reflects the editing rapidity of a periodical, and N/Y,

the ratio of deposited contribution quantity to the publishing quantity in one year which reflects the waiting period of adopted papers deposited in editorial board. For a periodical, if τ is more than three months, we can conclude that it should speed process with modern techniques. If N/Y is very large, the editorial board should reduce publication delay by cutting down the deposited contribution quantity N and adding the published literature flux Y.

(2) $\overline{T}$ is independent of the deposited contribution publishing probability *P(T)*. The distributing strategy, which is a mode of editor-in-chief selecting papers to publish by age, merely influences on the age distribution of deposited or published contribution. Because $\overline{T}$ does not change with *P(T)* at steady states, it is useless to reduce publication delay by the shift of distributing strategy of every issue.

Delay indicators of seven international journals

Seven international journals are sampled and their statistical data of publication delay are collected and analyzed. the delay characteristic parameters(τ, N, Y) and $\overline{T}$ of every journal are calculated by the particular solution of Eq. 6 under condition of equal publishing probability (YU et al., 2000) and Eq. 9. The solution method is same as parameters solution method of the secondary literature publishing process in the literature (YU et al., 2003, p. 681), it shouldn't be described repeatedly. The volumes and issues of seven journals and number of statistical papers are:

(1) *IEEE Transactions on Automatic Control* 2002, (1-12), 281 items;
(2) *IEEE Transactions on Aerospace and Electronic Systems* 2002, (1-4), 148 items;
(3) *Journal of Mathematical Physics* 2002 (1-12), 300 items;
(4) *Journal of the European Ceramic Society* 2002 (1-12), 268 items;
(5) *International Journal of Engineering Science* 2000(1-18), 2001(1-8), 161 items;
(6) *Information Processing and Management* 2000(3-6), 2001(1-6), 2002,(1-6), 91 items;
(7) *Scientometrics*, 2002–2003, 121 items.

The calculation results are shown in Table 1. From these results, we know that

(1) It is more complex that pure delay τ images physical meaning in statistics of publishing delay data and process simulation. Firstly magnitude of pure delay shows the time of reviewing, revising and processing; Secondly images the time including the lowest time of waiting in line (waiting to publish);
(2) It must be clearly that the deposited contribution quantity N is the quantity of deposited papers in the editorial office waiting for publishing but the number of manuscripts in reviewing, processing and revising;

(3) The publication delay indicators of seven journals show that the delay indicators of SCIENTOMETRICS and J MATH PHYS are smaller; the indicator of SCIENTOMETRICS is 0.4567 years (5.5months). The delay indicator of IEEE T AERO ELEC SYS is the longest one, which reaches 20 months, the information ageing degree of the journal is higher then others. To long delay will badly influence on communication and transmitting of scientific production and must be effectively reduced by some means.

Table 1. Delay indicator of seven international journals

Periodical title	τ (years)	N/Y (years)	$\overline{T} = \tau + N/Y$ (years)
IEEE T AUTOMAT CONTR	0.7868	0.8194	1.6062
IEEE T AERO ELEC SYS	0.7895	0.8861	1.6756
J MATH PHYS	0.3894	0.3617	0.7511
J EUR CERAM SOC	1.1255	0.2529	1.3784
INT J ENG SCI	0.9752	0.5798	1.5550
INFORM PROCESS MANAG	0.8772	0.4970	1.3742
SCIENTOMETRICS	0.2366	0.2198	0.4567

Discussion about the indicator of periodical publication delay

It must be based on some theoretic studies that a science indicator is established and has certain actual value. The indicator of periodical publication delay is a valuable indicator based on studies of bibliometrics, and some discussion about its applications is given as followings:

(1) The indicator can be used as a quantitative tool for editors to inspect and supervise the publication process of their periodicals. For a periodical, if editors have known the pure delay τ and the deposited contribution flux N, according to the published literature flux Y, they can predict the average publication delay with Eq. 10. When they see the status of publication delay, they can adjust the adopting and publishing strategy to change the publication delay. For example, a monthly periodical has issued for ten years. The time of reviewing and revising is about three months, the deposited contribution quantity is 240 items (not including the number of manuscripts in reviewing, processing and revising) (N=240 items), and the published literature flux is 20 items/month (Y=20 items/month), so the average delay is about 15 months. It is obviously too

long and should be reduced. Editors of the periodical would improve the ability of the process by some modern means, or cut down the deposited contribution quantity, or increase publication quantity by some supplement.

(2) The average publication delay is a valuable indicator to evaluate periodical publication. The longer delay is, the higher information ageing degree of literature is. At present, due to lack of quantitive evaluating tool, the degree of information ageing of periodical cannot be evaluated in periodical quality evaluation. So the indicator should be adopted to evaluate the information ageing degree of a periodical. In the process of measuring and evaluating a periodical publication delay, administrative organization of technological periodicals should gather the characteristic parameters of the process: τ, Y and N, and figure out the average publication delay of every periodical, and compare information ageing degree of periodicals for a given period, and estimate qualities of them.

(3) Based upon the delay indicator, some other studies on bibliometrics can be carried out. Now the indicators of bibliometrics(QIU, 1988; DING, 1992) is widely used to evaluate the scientific productivity, scientists, scientific research institutes, scientific periodicals, even impact of a country around the world. Impact factor, Immediately Index and etc. play important roles in evaluating science periodicals. The publication delay has directly effect on the increasing, spreading, and aging of periodical literature. EGGHE & ROUSSEAU (2000) showed how the "undisturbed" aging function and the publication delay combine to give the observed aging function by a mathematical operation known as convolution. YU & YU (1998) proposed a new idea that all the obsolescence models should be corrected so as to reflect the publication delay influence of document citation, and verified the idea with SCI's citation data. Impact Factor and Immediately Index have a close relation with citation and are influenced by the publication delay, hence the indicator of periodical publication delay is very important to measure and evaluate information ageing degree of technological periodicals.

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Project (HIT.200081) supported by the Scientific Research Foundation of Harbin Institute of Technology.

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