Evolution of the Development of Scientometrics

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Abstract

The term "Scientometrics" was coined in 1969 by scholars from the former Soviet Union. After decades of growth, the international field of scientometrics has become increasingly mature. This research examines the growth of the Scientometrics journal, measured by annual publication number and growth, annual citation frequency, annual growth of citation frequency by applying correlation analysis and regression analysis, in an attempt to model the literature growth of the journal. By considering internationally important events in the field of scientometrics since 1978, the growth of the discipline is divided into three stages. Each stage is further analyzed using regression analysis to trace the literature growth. In addition, based on visualization method, the main topic areas are identified for each of the three stages of scientometrics' development.

1   Background

The term "Scientometrics" has been first used as a translation of the Russian term "naukometriya" (measurement of science) coined by Nalimov and Mulchenko (1969). The research area of scientometrics began during the second half of the 19th century. It has over 100 years of history. During this time, scientists' studies of scientometrics shifted from the unconscious to consciousness, from qualitative research to quantitative research, and from external description to detailed study revealing the inherent properties of scientific production. Previous Scholars (Pang, 2002; Yuan, 2010) tend to divide the development of scientometrics into three stages: embryonic period (from the second half of the 19th century to early 20th century), the founding period (from the beginning of the 20th century to the 1960s), and development period (after the 1970s). And in order to study the development period of scientometrics, Schubert A. (2002) indicated that as the representative communication channel of its field, the journal Scientometrics reflects the characteristic trends and patterns of the past decades in scientometric research. That's why this study – like some of its predecessors (Schoepflin & Glänzel, 2001; Hou, 2006) – uses the journal as a representative model of scientometrics research.

2   Purpose

This paper proposed a comprehensive statistical overview of the journal Scientometrics to study the evolution of scientometrics. Quantitative analyses and informetric methods are employed to describe the evolution of scientometrics during nearly 40 years after entering the development period. And then, using visualization methods to display the growth of publication and the main research areas of each stage of the development period.

3   Data and Methods

For the development period of scientometrics, the foundation of the journal Scientometrics (in September, 1978) is a landmark event. The research data involves 3482 documents published in Scientometrics during 1978 to 2013 retrieved from the Web of Science on August 20th, 2013. Using Microsoft Excel to count Scientometrics' annual publication number, annual cited frequency, and annual growth of cited frequency, and using correlation analysis and regression analysis to simulate the field of literature growth curve by SPSS. In addition, choosing highly cited papers from each stage of the development period, and using document co-citation analysis, factor analysis and multidimensional scaling analysis reveal the main research areas of each stage.

4   Results

According to the analysis of the annual number of publications, annual cited frequency, annual growth of publication number and annual growth of cited frequency, the growths of number of annual publication and cited frequency show the similar trends, continuing with rapid growth after a period of relatively flat growth (shown in the Figure 1 and Figure 2). The changes in growth rate between the annual publication number and cited frequency follow similar tendencies, showing continued volatility after the first vertex (shown in the Figure 3 and Figure 4).
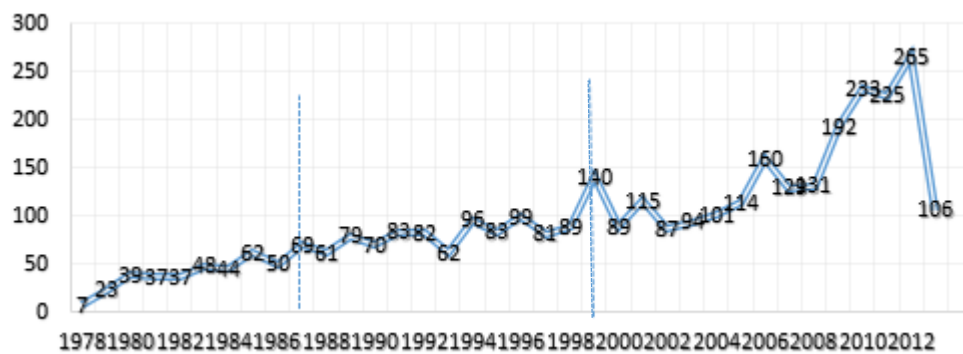

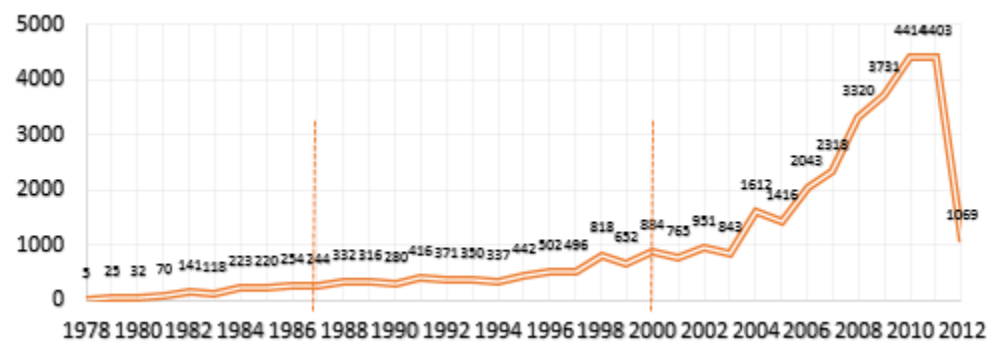Figure 1: Annual publication number of Scientometrics

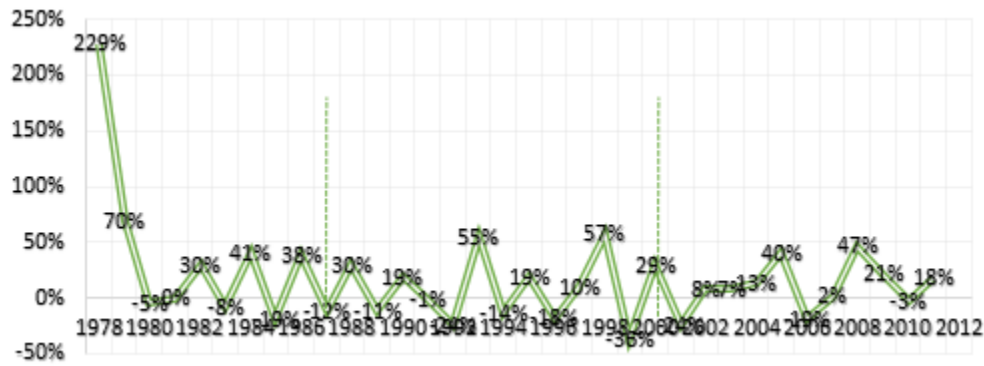Figure 2: Annual cited frequency of Scientometrics

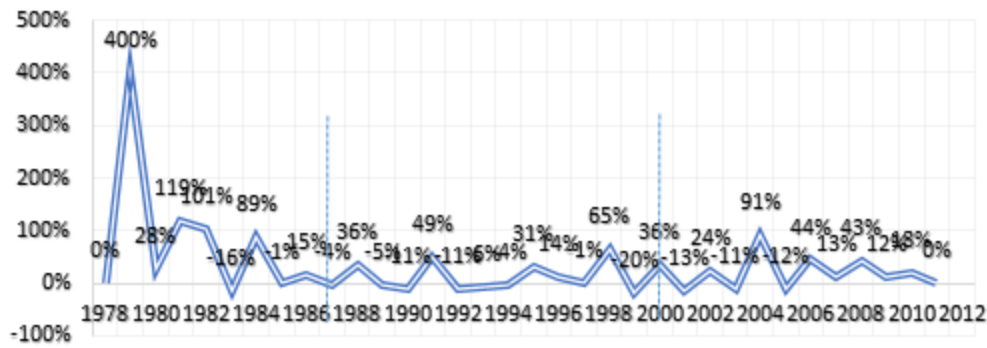Figure 3: Annual growth of publication number

Figure 4: Annual growth of cited frequency

A bivariate correlation analysis between the publication number and the publishing time resulted in a Pearson correlation coefficient of 0.880, which is significant at the 0.01 significance level (two-sided). The data were modeled against different growth functions. A logistic function shows relatively high fitness based on R square and F values. This indicates that the Logistic model provides the best fit to simulate the growth of articles in the journal Scientometrics'. The fitted curve is shown as Figure 5, with the estimate of parameters appearing in Table 1.

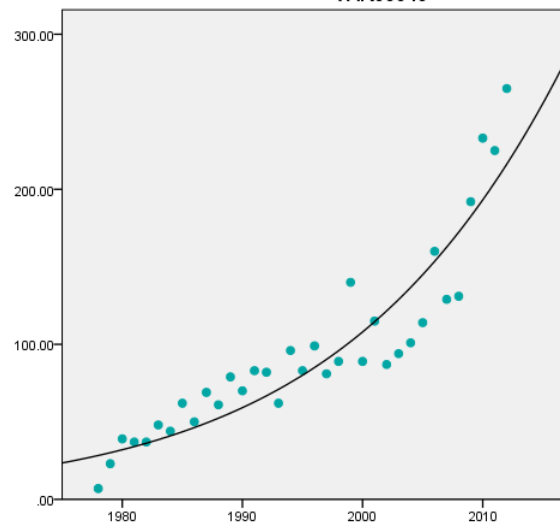|	R square	F	df1	df2	Sig.	Constant	b1
Logistic	.792	125.715	1	33	.000	2.671E52	.939

Table 1: The estimate of parameters

Figure 5: Scientometrics' paper growth curve fitting

Taking all the trends of the Figure 1 to Figure 4 into account, and referring to the important events in the international field of scientometrics from 1978 to present, the evolution of scientometrics can be divided into three stages: Early development stage (from 1978 to 1986), Gradual maturing stage (from 1987 to the end of the 20th century) and the Golden development stage (from the beginning of the 21th century to present). The fitted curves of the growth of the publication number with publication time are shown respectively in Figure 6, Figure 7 and Figure 8. The regression analyses reveal that the growth of the number of publications during the first stage and third stage separately follow a linear distribution and exponential distribution, respectively. However, the data of the second stage shows relatively big fluctuations resulting in poor fits for linear and nonlinear models.
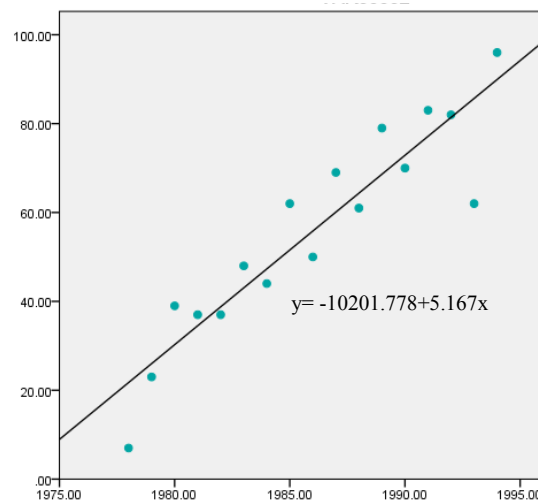

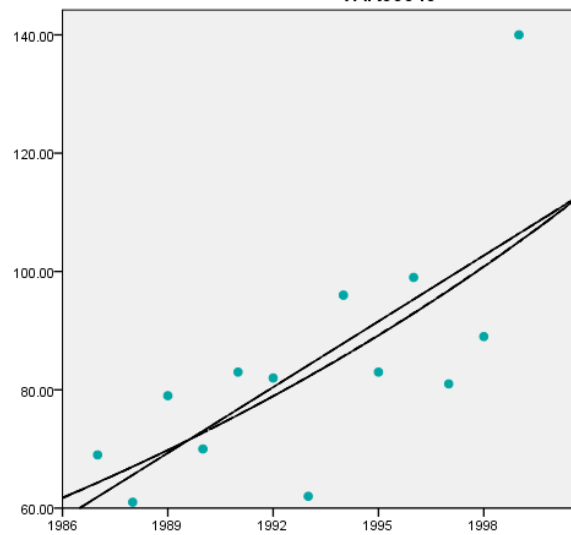Figure 6: Scientometrics' paper growth curve fitting of early developing stage

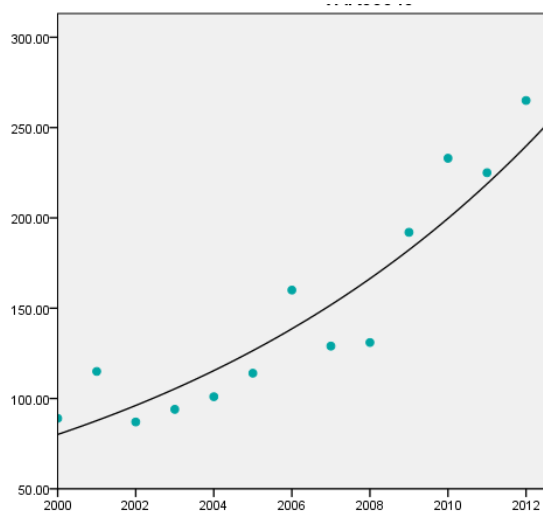Figure 7: Scientometrics' paper growth curve fitting of gradually maturing stage

Figure 8: Scientometrics' paper growth curve fitting of golden developing stage

The outcomes of document co-citation analysis, factor analysis and multidimensional scaling analysis reveal the main research fields of each stage. The early development stage has five main fields. The arrangement reflects the principal components variance contribution as follows: (1) scientific literature structure, citation analysis theory; (2) bibliometric laws of quantitative and statistical; (3) application of citation analysis, scientific cooperation; (4) discipline analysis; (5) evaluation of scientific research. During the gradual maturing stage also contains five main themes: (1) citation theory, basic scientific research evaluation; (2) scientific collaboration; (3) co-citation, science mapping; (4) scientometric indicators, application of bibliometrics; (5) scientific elite. Seven focusing topics arises during the golden development stage: (1) application of citation indexes, patent analysis; (2) assessment of research performance; (3) scientometrics classic probability distribution and its application; (4) social network analysis and scientific research collaboration, the university ranking; (5) hirsch-type index; (6) research collaboration and national research performance; (7) application and visualization of scientometric indicators. Figure 9, Figure 10 and Figure 11 respectively present the results from multidimensional scaling analysis. The thickness of each principal component boundary line reflects the heart of the research field and the distribution of the influence.
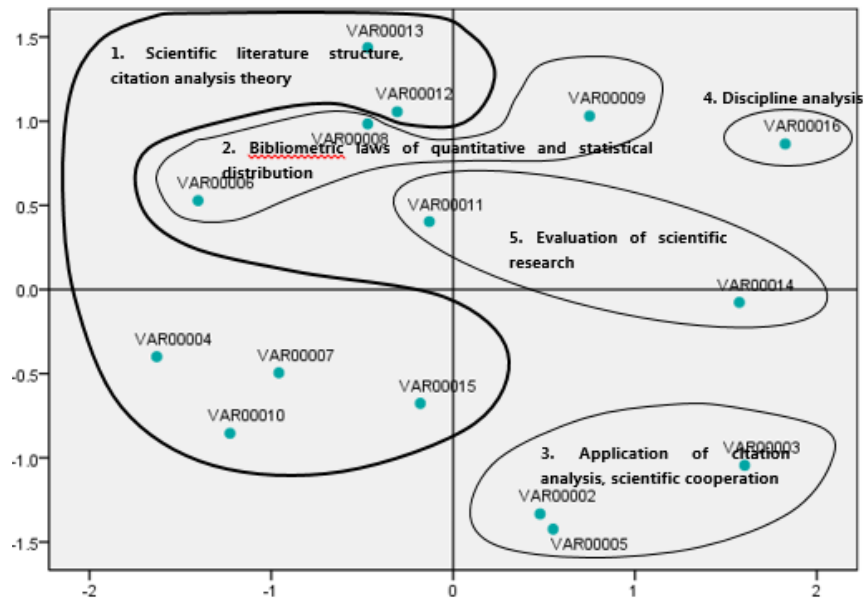
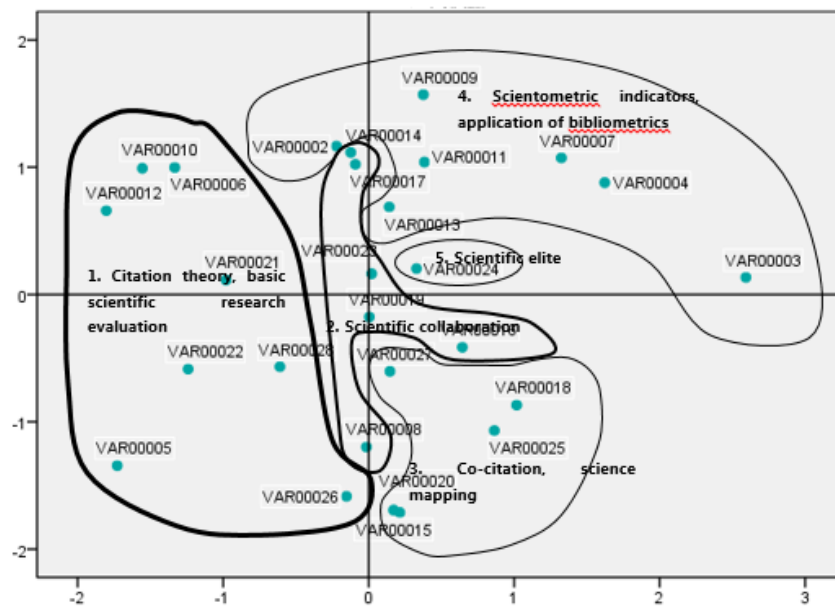Figure 9: Main research field of early development stage of scientometrics

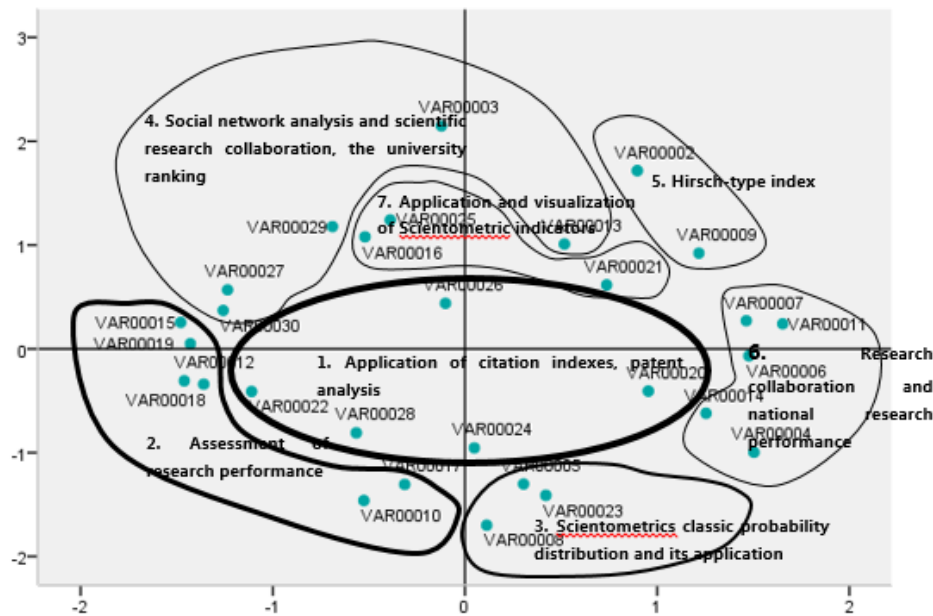Figure 10: Main research field of gradually developing stage of scientometrics

Figure 11: Main research field of golden developing stage of scientometrics

5   Conclusions

According to the results of the regression analysis, the growth trends of publication of the three stages of the development period exactly fit the scientific literature's growth model proposed by Price (1951). Scientometrics has been experienced rapid growth in the amount of literature being published. This trend likely to continue. On the other hand, through comprehensive and comparative review of the main research areas of each stage, we can draw the following conclusions: (1) citation analysis has been a core research area during every stage; (2) research interest has shifted from theoretical research to applied aspect; (3) visualization methods and scientific mapping have attracted more and more attention and will become a main research area of scientometrics.

6   References

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