

Research Performance and Impact of the Chung Yuan Christian University: A

Bibliometric Study with Peak-Year Citation per Publication Indicator

Te-Chen Yu and Yuh-Shan Ho*

Trend Research Centre, Asia University, Taichung 41354, Taiwan

*Author to whom all correspondence should be addressed

Tel: 866 4 2332 3456 ext. 1797

Fax: 866 4 2330 5834

E-mail: ysho@asia.edu.tw

Methodology

In the 2006 edition of the *Journal Citation Reports* (JCR), 6,164 journals are listed in the SCI. Documents used in this study were based on the database of the SCI retrieved from the ISI Web of Science, Philadelphia, PA, USA. The Chung Yuan Christian College of Science and Engineering (CYCC) has changed its status to Chung Yuan Christian University (CYCU) in year 1980; article published by CYCC prior to 1980 has been added to CYCU data. “Chung Yuan same Taiwan” were used as keywords to search address. It may include Chung Yuan Christian Univ, Taiwan; Chung-Yuan Christian Univ, Taiwan; Chung Yuan Christain Univ, Taiwan; Chung Yuan Christian Univ, Taiwan; Univ Chung Yuan Christian, Taiwan; Chung Yuan Univ, Taiwan; Natl

Chung Yuan Univ, Taiwan; Natl Chung Yuan Christian Univ, Taiwan; Chung Yuan Christian Coll Sci & Engr, Taiwan; and Chung Yuan Coll Sci & Engr, Taiwan. Articles originating from England, Scotland, Northern Ireland, and Wales were re-categorized as being from the United Kingdom. Collaboration type was determined based on the address of each author, with the term “independent article” being assigned if the addresses of the researchers were in CYCU. The term “national article” was assigned to articles co-signed by researchers were in Taiwan. The term “international article” was assigned to articles co-signed by researchers from multiple countries. All numerical analyses used integer counts, i.e. if a article was authored by authors from two different countries, each country was counted once, thus in some cases percentages will add up more than 100.

Downloaded information included names of authors, author address, title, year of publication, keywords, times cited, subject categories of the article, names of journal publishing the article, and publisher information. The records were downloaded into spreadsheet software, and additional coding was performed manually for the number of authors, country origin of collaborators, and impact factors of the publishing journals.

The reported impact factor (IF) of each journal was derived from the 2006 JCR. The IF of a journal is defined by the *JCR*, and is derived by dividing the number of current citations to articles published in the previous two years by the total number of articles

published in those years. It is a measure of the frequency with which the average article in a journal has been cited in a particular year. The IF is used to evaluate a journal's relative importance, especially when compared to others in the same field.

To assess the visibility of an article, we used the number of times it was cited as an indicator. However, the numbers of times cited for an article is highly correlated with the length of time since its publication. To adjust for that, a new variable was created.

Figure 1 shows the relationship between the average number of times cited per publication and the number of years since its publication for the 2,514 articles. It shows that the frequency of being cited was highest in the 3rd full year since its publication, and began to decrease afterwards. Thus, to adjust for the bias due to differences in length of time since publication, a new variable TC (times cited before year 3), instead of just times cited since publication, was used to assess the visibility of articles. A TC for year 2001 would be the number to times being cited before the end of 2003 for all the articles published in 2001. Another variable CPP (citation per publication) for articles published in a particular year was calculated as TC divided by the number of articles published in that year.

Results and Discussion

Article Characteristics

The number of articles published by the Chung Yuan Christian University (CYCU) researchers in the journals listed in SCI has been increasing significantly since 1973. The year-wise output is displayed in Table 1 and the growth of publications by CYCU researchers relative to Taiwan publications. In 1973, there was only 1 article. After 1991, there has been a steady increase but there was a decrease in 2000, after that a steady increase was occurred. In 2005, it has reached 253 articles, and in 2006, it has increased to 314 articles. The article growth rates of CYCU and Taiwan, from 1973 to 2006, are steadily rising. It is clear from Fig. 2 growth rates for CYCU and Taiwan was similar in the studied period. The research and publication trend in the area of CYCU has been steadily increased in the period from 1991 to 1994, after that growth rate was sustained for yearly publications. A significant correlation was found between the yearly cumulative number of articles and the year (Fig. 3). In 1991, 41 articles were published, while in 2006 the cumulative number of publications was 2,393. The relationship between yearly cumulative number of articles, P , and the year, Y , was linear with good coefficients of determination (0.984 for 1991 – 1994, 0.998 for 1994 – 2006) with models as follows:

For 1991 – 1994

$$P = 38.5Y^{1.19} \quad (1)$$

For 1994 – 2006

$$P = 18.3Y^{1.75} \quad (2)$$

Due to the high coefficients of determination of Eq. (2), publication of CYCU could be estimated using this model.

Figure 4 shows a trend of the number of citation per publication (CPP) and the number of articles. CPP is calculated as TC divided by the number of articles published in that year. No value was given after year 2003, since it has been less than three years since its publication. Only 1,693 articles had a CPP value (1987-2003). Data showed that CPP has been fluctuating and increasing over the years. The average CPP was 2.9. CPP was lowest in year 1988 with 1.1 but was highest in year 2002 at 4.2. The highest TC (53) article was a national collaborative, published in 2002 in *Chemistry of Materials* by 5 authors who were from Chung Yuan Christian University and Nanya Institute of Technology at Taiwan. Department of mathematics had the highest TC (31) independent article, also published in 2002 in *Pattern Recognition*. In addition, IF and TC were significantly correlated with correlation coefficient of 0.382 ($p < 0.001$) for 1,585 articles.

International Collaboration

In terms of international collaboration, 14% of all articles published since 1973 has had international co-authorship (ICA). The percentage of articles with ICA is listed in Table 1. In general, ICA articles were more prevalent in earlier years than recent years. Using

5-year intervals, the percentage of articles with ICA were 49%, 13%, 15%, 12%, and 12% for the periods 1982-1986, 1987-1991, 1992-1996, 1997-2001, and 2002-2006 respectively. It appeared that articles with ICA had higher visibility than others. Of the 1,742 articles that had a CPP value, a total of 251 articles had ICA, with an average CPP of 3.2, while the others only averaged 2.8. Table 2 shows co-authorship countries, number of articles, TC, and CPP value. The most co-authored country was the US with 156 articles (62% of all ICA articles) and a CPP of 3.6. It is not surprising USA was the country that CYCU researchers collaborated with most often, since many researchers were trained in the US. Canada was the second most co-authored countries with 29 articles (12%) and a CPP of 1.3. Furthermore, CPP values of these co-authored articles were lower than those co-authored with US. It is likely that CYCU research will benefit from closer ties with the US.

National Collaboration

Of the 1,491 non-international collaborative articles with TC, 788 were published by researchers in CYCU. Table 3 shows the number of articles for co-authorship institutes that has published at least 15 national collaborative articles (NCA) since 1973. Some institutes have changed their status from a college to a university, and data for these institutes were grouped together under the new name. For instance, since Nanya Junior College of Technology (NJCT) has changed its status to Nanya Institute of Technology

(NIT) in year 1990, article published by NJCT prior to 1990 has been added to NIT data.

In Table 3, the institutes were listed in descending order of the number of total national collaborative articles published. National Taiwan University (NTU) had the most number of publications with 99 articles, followed by Nanya Institute of Technology (NIT) with 53 articles, and National Central University (NCU) with 52 articles. Among the top 15 national co-authorship institutes, 11 were universities, 3 were research institutes, and 1 was hospital. Eighty-six percent of all CYCU articles were non-international collaborative articles (1,491). Forty-seven percent of these articles were national collaborative articles. Fifty-one percent of all CYCU articles were independent articles. In addition, CYCU had 1,189 (68%) first author articles with CPP of 2.7 that was lower than others articles with CPP of 3.0. Similarly, CYCU had 1,108 (64%) corresponding articles with CPP of 2.7 that was also lower than others articles with CPP of 3.1. Of the 1,491 non-international collaborative articles that had a CPP value, a total of 788 single-institute articles were published by CYCU, with an average CPP of 2.5, while the others averaged 3.1. Table 3 listed institutes published at least 15 articles. In terms of CPP values for national collaborative articles. Academia Sinica and National Taiwan University Hospital lead the other institutes with 5.6, followed by Industrial Technology Research Institute (5.2), and National Yunlin University of Science and Technology (5.1). It was not surprising that Academia Sinica is one of top

research institute in Taiwan and in general article with medical topic would be cited more. Comparisons showed that the 1 hospital had CPP of 5.6 and 3 research institutes had an average CPP of 4.7, higher than the average CPP of 3.3 for the 11 universities. The CPP does not actually indicate the quality of a paper, but is a measure of its impact or visibility. For CYCU, the value of CPP for the international collaborative articles was 3.2 that were higher than the CPP of 2.8 for the non-international collaborative articles. In addition, the value of CPP for national collaborative articles was 3.1 that was higher than the CPP of 2.5 for the single-institute of CYCU articles.

Journals, Subject Categories, and Keywords

Table 4 shows the names of journals (published at least 15 CYCU articles), number of articles published by these journals, CPP, subject categories, IF, and ranking. The journal that published the most number of articles by CYCU researchers was *Journal of Applied Polymer Science* with 66 articles, followed by *Journal of Membrane Science* (42), *Journal of Sound and Vibration* (39), *Journal of Polymer Science Part A-Polymer Chemistry* (37), and *Chinese Journal of Physics* (36). The 15 articles published in *Polymer* had an averaged CPP of 14, and *Physical Review D* had a CPP of 12. Contrary to what is expected, there is no relationship between CPP and IF for these articles. In other words, for CYCU articles, the CPP is not associated with the impact factor of journals that publish these articles. The values of CPP were higher than IF in 85% of the

20 journals in Table 4. Impact of CYCU articles published in these journals was higher than average level. Moreover, *Nature* also had the highest IF (26.681) of all the journals publishing CYCU articles. However, the *Chemistry of Materials* which published 3 articles had the highest CPP of 53, 44, and 16.

The 1,742 articles with CPP and subject category information were distributed over 118 subject categories. Table 5 shows the categories that had at least 50 articles. The five top categories with the most number of articles (> 100) were electrical & electronic engineering (240), polymer science (231), chemical engineering (194), mechanics (119), and mechanical engineering (110). The highest CPP were polymer science (4.5), and followed by biomedical engineering, (4.3), and multidisciplinary materials science (4.1).

Of the 887 articles with author keyword information had CPP values. Examination of author keywords revealed that 2,741 keywords were used. Among them, 2,259 (86%) keywords appeared only once, 300 (11%) keywords appeared twice, and 84 (3.1%) keywords appeared three times. The large number of once-only author keywords probably indicates a lack of continuity in research and a wide disparity in research focuses. Table 6 shows keywords that appeared at least 10 times. The most frequently used keyword was 'pervaporation', appearing in 3.5% of articles with CPP of 2.5. The 2nd most frequently used keywords were 'vector quantization' at 2.0% with CPP of 0.8.

‘Thermal properties’ and ‘active filters’ were used 14 times at 1.6% with CPP of 6.9 and 5.0 respectively.

Year Research Impact Citation model (YRIC model)

In order to compare research performance for each year, a model can be used to describe the relationship between cumulative citation per publication, CPP and the paper life (year since it was published), Y . The model can be expressed as:

$$CPP = KY + S \quad (3)$$

Where constants K is the CPP increasing rate (CPP/year), and S is the CPP at publishing year. Moreover, K is a measure of how quickly the CPP is increased and is an indicator of research impact. The S is visibility potential when yearly papers are published. Figure 5 shows that significant correlations between the yearly cumulative CPP and the article life were made for the years from 1991 to 2000 with the model having high coefficients of determination (> 0.989). The values of the constants K and S for CYCU research of each year were shown in Fig. 6. The results indicated that CYCU articles published in 1997 had the higher CPP increasing rate in later years. However, the higher visibility potential was found in earlier years. In other words, CYCU research articles published in earlier years had the higher visibility when articles were published.

Conclusion

Scientific research in CYCU has increased significantly over the last 34 years. The overall quality of research appeared to be improving, as indicated by an increase in the citation per publication values of recently published articles. The numbers of articles with international co-authorship had significantly higher CPP values than the others. Correspondingly, the numbers of articles with national co-authorship had significantly higher CPP values than the CYCU single author. CYCU should try to increase its impact of independent research work. Another sign of concern is that research in CYCU covers a wide range of sub-topics, as indicated by the large number of one-time-only author keywords used in these articles.

Table 1: Articles characteristics by year of publication

Year	CYCU	Taiwan	% of Taiwan	TC	CPP	ICA (%)
1973	1	177	0.56	3	3.0	100
1974	0	191	0	0	0	0
1975	0	224	0	0	0	0
1976	0	255	0	0	0	0
1977	0	315	0	0	0	0
1978	2	372	0.54	13	6.5	50
1979	1	391	0.26	2	2.0	0
1980	4	395	1.0	13	3.3	0
1981	5	437	1.1	3	0.60	0
1982	8	489	1.6	5	0.63	25
1983	4	572	0.70	12	0	50
1984	5	649	0.77	1	0.20	60
1985	5	878	0.57	9	1.8	80
1986	14	1,030	1.4	10	0.71	29
1987	19	1,381	1.4	25	0	0
1988	18	1,699	1.1	20	1.1	22
1989	10	1,973	0.51	12	1.2	20

1990	25	2,441	1.0	43	1.7	12
1991	41	3,048	1.3	92	2.2	12
1992	36	3,776	0.95	102	2.8	19
1993	66	4,331	1.5	184	2.8	1.5
1994	69	5,282	1.3	148	2.1	13
1995	84	5,867	1.4	206	2.5	18
1996	111	7,514	1.5	281	2.5	23
1997	157	7,990	2.0	370	2.4	8.3
1998	166	8,635	1.9	342	2.1	14
1999	195	9,121	2.1	444	2.3	17
2000	133	9,623	1.4	456	3.4	9.0
2001	180	10,752	1.7	591	3.3	12
2002	198	11,251	1.8	831	4.2	15
2003	185	12,385	1.5	720	3.9	16
2004	205	13,897	1.5			10
2005	253	15,284	1.7			9.5
2006	314	17,297	1.8			11
Total	2514	159,922	1.6			329

Note: TC = Times cited before the third year since publishing for CYCU articles; CPP =

Citation per publication for CYCU articles; ICA = International Co-authorship

Table 2: International collaboration by countries

Co-authorship country	Number of articles	% of co-authored article	TC	CPP
USA	156	62	567	3.6
Canada	29	12	38	1.3
Japan	23	9.2	60	2.6
China	20	8.0	60	3.0
Germany	12	4.8	71	5.9
Australia	7	2.8	28	4.0
Poland	6	2.4	11	1.8
India	5	2.0	19	3.8
Singapore	3	1.2	11	3.7
UK	3	1.2	4	1.3
Russia	2	0.80	13	6.5
Spain	2	0.80	3	1.5
Hong Kong	2	0.80	0	0
France	1	0.40	3	3.0
Greece	1	0.40	3	3.0
Belgium	1	0.40	1	1.0
Turkey	1	0.40	1	1.0

Brazil	1	0.40	0	0
Federal Republic of Germany	1	0.40	0	0
Finland	1	0.40	0	0
Italy	1	0.40	0	0
Mexico	1	0.40	0	0
Sweden	1	0.40	0	0

Notes: N = 251

Table 3: National collaboration by institutes

Institute	No. of NC	TC3	CPP
National Taiwan University	99	390	3.9
Nanya Institute of Technology	53	118	2.2
National Central University	52	119	2.3
Chung Shan Institute of Science and Technology	46	149	3.2
Academia Sinica	41	230	5.6
National Tsing Hua University	38	104	2.7
Soochow University	37	155	4.2
National Cheng Kung University	28	87	3.1
National Chiao Tung University	24	42	1.8
National Taiwan University Hospital	20	112	5.6
Industrial Technology Research Institute	20	104	5.2
National Yunlin University of Science and Technology	19	97	5.1
National Yang Ming University	19	54	2.8
Yuan Ze University	19	40	2.1
National Taiwan University of Science and Technology	19	25	1.3

NC: number of national collaborative article

Table 4: Journals publishing CYCU articles

Name of Journal	Article	CPP	IF	Subject category	Ranking
Journal of Applied Polymer Science	66	3.5	1.306	Polymer Science	29/75
Journal of Membrane Science	42	4.8	3.442	Chemical Engineering	3/110
				Polymer Science	5/75
Journal of Sound and Vibration	39	1.5	0.884	Acoustics	12/28
				Mechanical Engineering	31/106
				Mechanics	47/109
Journal of Polymer Science Part A-Polymer Chemistry	37	5.8	3.405	Polymer Science	6/75
Chinese Journal of Physics	36	0.44	0.238	Physics	66/68
Journal of the Chinese Chemical Society	34	0.94	0.577	Multidisciplinary Chemistry	88/124

Electronics Letters	26	3.8	1.063	Electrical & Electronic Engineering	69/206
International Journal of Electronics	23	2.0	0.459	Electrical & Electronic Engineering	141/206
Thermochimica Acta	21	0.38	1.417	Analytical Chemistry	35/68
				Physical Chemistry	68/108
European Polymer Journal	20	1.9	2.113	Polymer Science	15/75
Journal of Chemical and Engineering Data	20	3.9	1.642	Multidisciplinary Chemistry	40/124
				Chemical Engineering	16/110
IEE Proceedings-Electric Power Applications	19	2.9	0.290	Electrical & Electronic Engineering	161/206
International Communications in Heat and Mass Transfer	18	2.1	0.708	Thermodynamics	27/42
				Mechanics	64/109
Journal of Applied Physics	18	1.7	2.316	Applied Physics	14/84

Materials Chemistry and Physics	18	1.7	1.657	Multidisciplinary Materials Science	44/175
Physical Review D	18	12	4.896	Astronomy & Astrophysics	8/45
				Particles & Fields Physics	5/21
Industrial & Engineering Chemistry Research	17	3.9	1.518	Chemical Engineering	23/110
Electric Power Systems Research	15	0.53	0.393	Electrical & Electronic Engineering	149/206
Physical Review E	15	2.7	2.438	Fluids & Plasmas Physics	5/24
				Mathematical Physics	2/41
Polymer	15	14	2.773	Polymer Science	9/75

Note: CPP = Citation per publication for CYCU articles published in perspective journals; IF = Impact factor of the journal in 2005.

Table 5: Number of articles and CPP by subject category

Subject category	Article	%	TC	CPP
Electrical & Electronic Engineering	240	14	556	2.3
Polymer Science	231	13	1,050	4.5
Chemical Engineering	194	11	569	2.9
Mechanics	119	6.8	240	2.0
Mechanical Engineering	110	6.3	207	1.9
Multidisciplinary Chemistry	86	4.9	223	2.6
Applied Physics	79	4.5	178	2.3
Applied Mathematics	78	4.5	119	1.5
Analytical Chemistry	74	4.2	251	3.4
Physical Chemistry	71	4.1	262	3.7
Multidisciplinary Physics	67	3.8	119	1.8
Interdisciplinary Applications Computer Science	65	3.7	125	1.9
Acoustics	57	3.3	127	2.2
Mathematics	57	3.3	54	0.95
Operations Research & Management Science	56	3.2	82	1.5
Multidisciplinary Materials Science	55	3.2	226	4.1
Biomedical Engineering	54	3.1	231	4.3

Automation & Control Systems

53

3.0

122

2.3

Table 6: Frequency of keywords used

Author keyword	Articles	%	TC	CPP
pervaporation	31	3.5	77	2.5
vector quantization	18	2.0	15	0.8
thermal properties	14	1.6	97	6.9
active filters	14	1.6	70	5.0
membrane	13	1.5	37	2.8
neural networks	13	1.5	13	1.0
fractional calculus	12	1.4	22	1.8
current conveyors	11	1.2	54	4.9
phosphorus	10	1.1	117	12
flame retardance	10	1.1	102	10
polycarbonate	10	1.1	42	4.2
wavelet transform	10	1.1	12	1.2

Figure 1. Citation per publication by article life

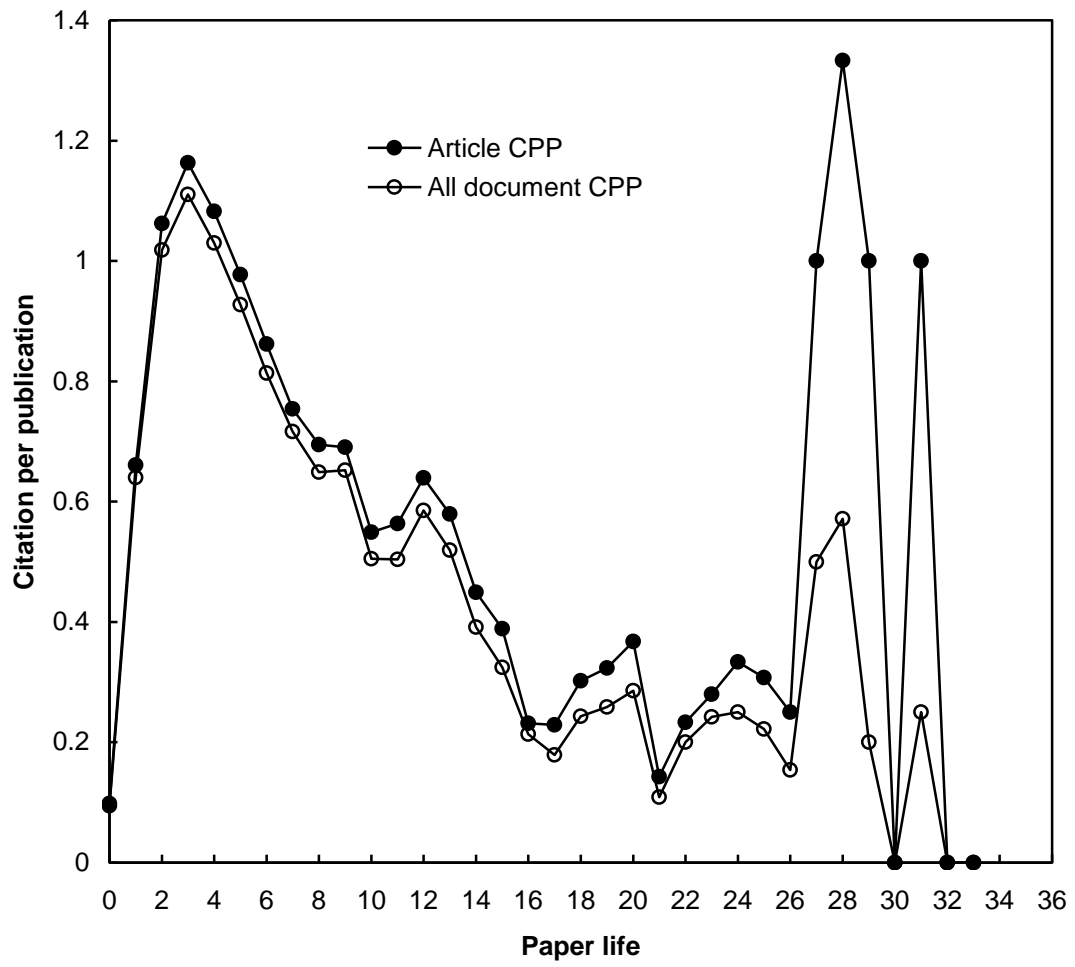


Figure 2. Number of articles published for CYCU and Taiwan 1973-2006

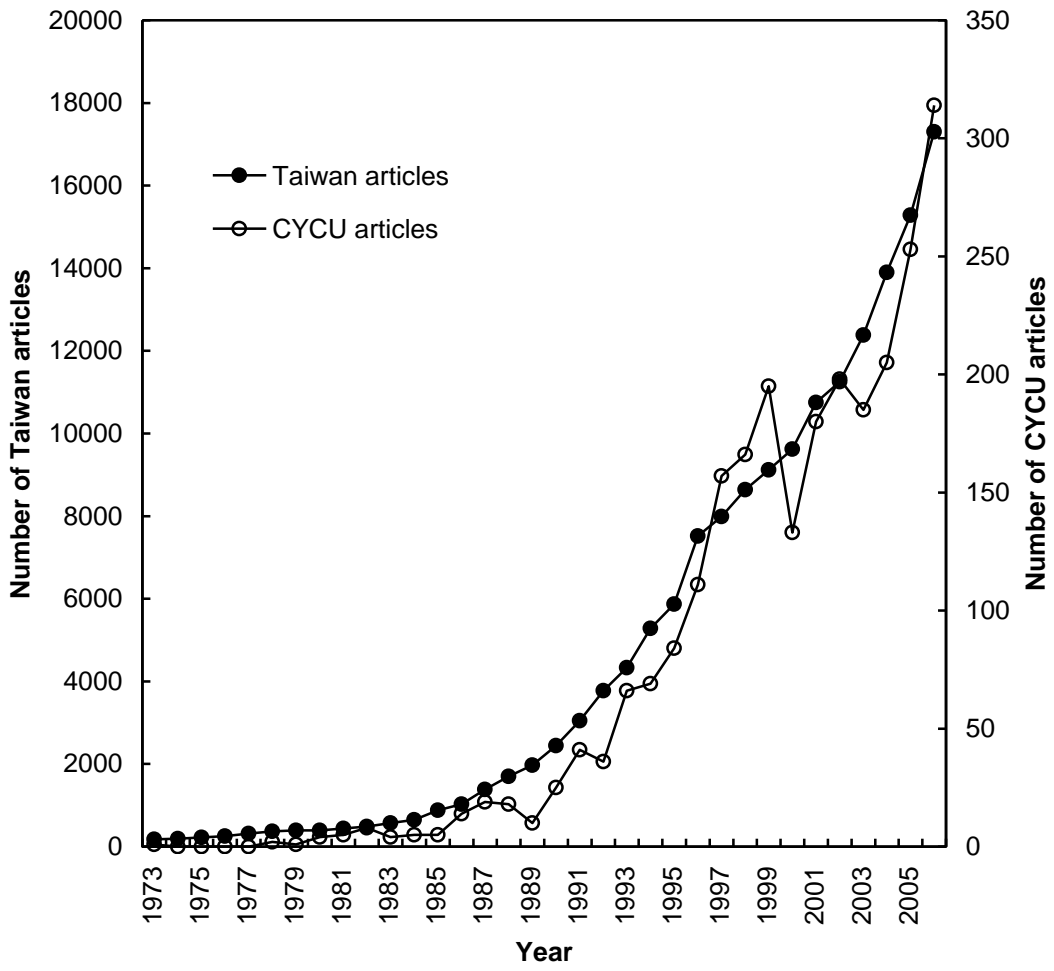


Figure 3. Cumulative number of publications by year

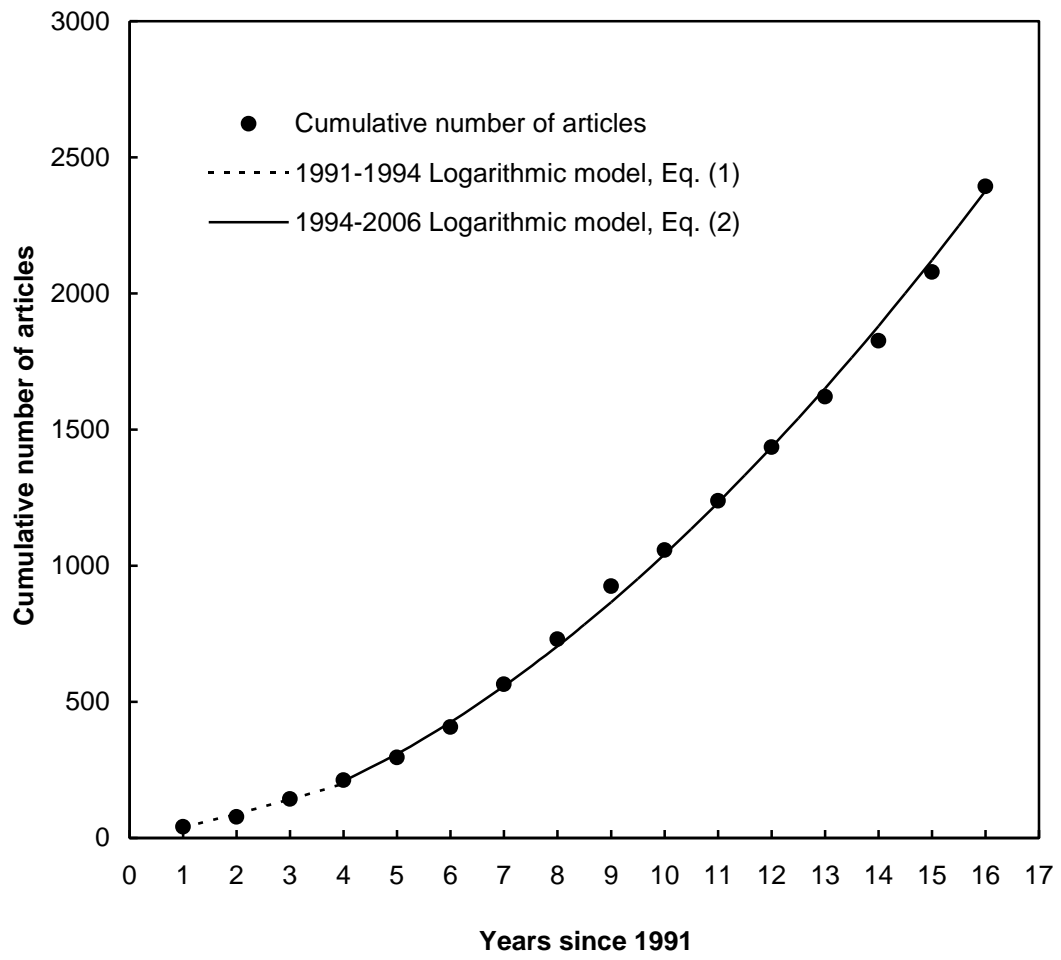


Figure 4. Number of research articles and citation per publications in CYCU 1987-2006

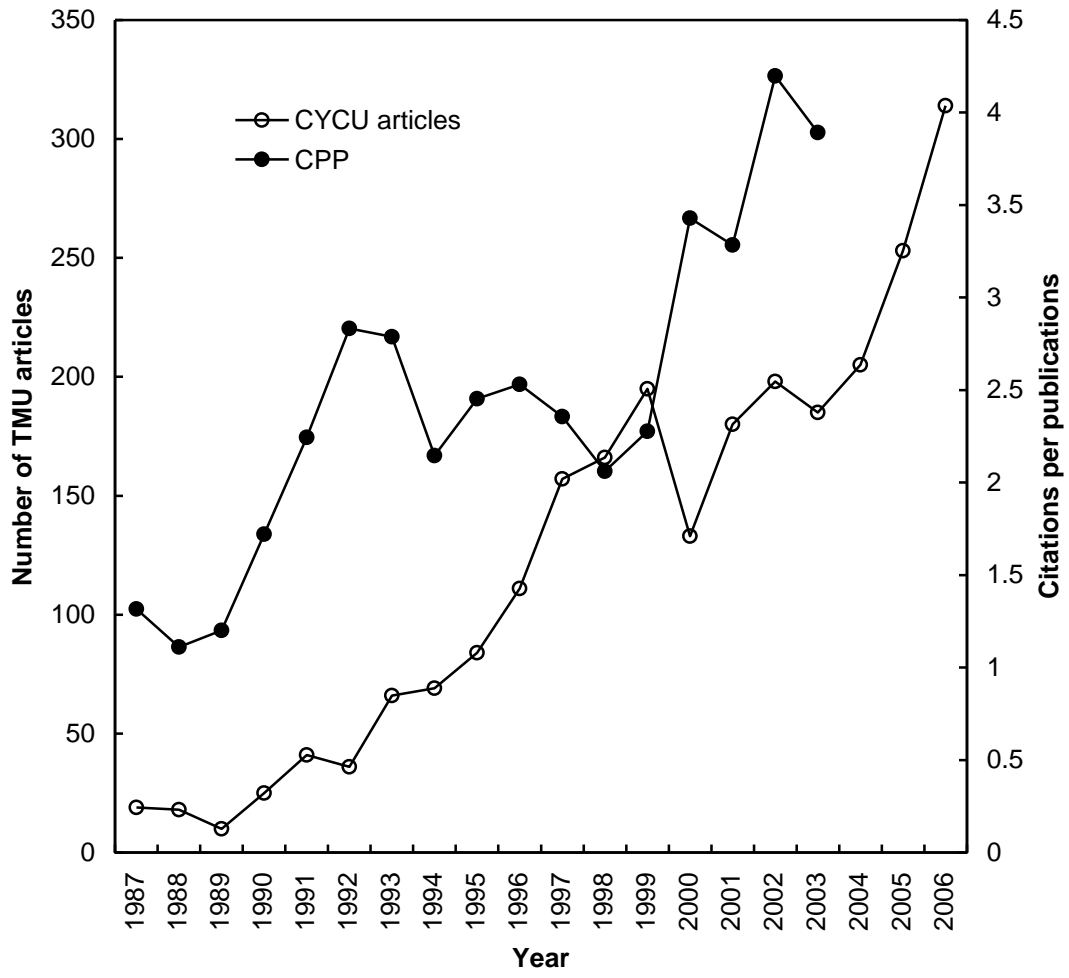


Figure 6. The constants K and S for the Chung Yuan Christian University research of each year

