Productivity pattern of universities in Kerala: A scientometric analysis

Aswathy S[a] and A Gopikuttan[b]

[a]Sr. Scientific Assistant, Library and Documentation Division, Liquid Propulsion Systems Centre, Indian Space Research Organisation,
Govt. of India, Valiamala P.O, Trivandrum – 695 547
E-mail: aswathysf@gmail.com
[b]Associate Professor, Department of Library and Information Science, University of Kerala, Palayam, Trivandrum – 695 001
E-mail: agopikuttan@yahoo.co.in

The study analyses the publication pattern of faculty members of three universities in Kerala viz., University of Kerala, Mahatma Gandhi University and University of Calicut. Authorship pattern, Degree of Collaboration, the appropriateness of Lotka's Inverse Square Law and year-wise and designation-wise distributions have been studied. The year-wise distribution of publications indicates that there is a growth in the number of publications. It is found that multi-authorship dominates among university teachers and there is no statistically significant difference between the experience and productivity. Designation-wise Degree of Collaboration shows that Professors are having a high Degree of Collaboration which indicates that increase in the age and experience results in more collaborative papers. The Lotka's inverse square law seems to be rejected for the present data set.

Keywords: Scientometrics, Publication productivity, Authorship pattern, Degree of Collaboration, Lotka's law

Introduction

The institutional prestige and reputation is associated with faculty publishing productivity and is strongly associated with an individual faculty member's reputation, visibility, and advancement in the academic reward structure, particularly at higher learning institutions. Being a unique research area, scientometrics is used to quantify national and international systems of innovation which helps in developing policy in science and technology and derives long term economic and social benefits. The growth rate of scientific research literature of nations, organizations, and departments or in a field of knowledge can be assessed using scientometric techniques. It is used to identify the pattern of publication, authorship, productive author, author affiliation, year-wise growth, citations and behavior of a subject over a period of time and thereby offering insight into the dynamics of the area under study which in turn may help to formulate science policy.

The measure of relationship between the output of research and inputs can be termed as publication productivity and evaluating the productivity of an institutional research and development activities highlights the contribution of the institution and the individual scientists engaged in research. Some insights into the complex dynamics of research activity are also provided which enables policy makers and administrators to provide adequate facilities and gauge the research activities.

Publication productivity is expressed by the number of papers published by a selected unit in a given time and universities can attain visibility, prestige, and credibility in the broader academic community by producing high quality research by which the reputation is enhanced and in turn, provides greater opportunity for attracting better students and faculty.

This paper deals with a scientometric study which analyzes the authorship pattern, degree of collaboration among authors and find out the year, designation and experience wise distributions. Also the fitness of Lotka's Inverse Square law is tested.

Review of literature

Beck[1] reports on the assessment of the standard of research at the Faculty of Natural Sciences of Lajor University by means of a scientometric evaluation of the publications activities of the department and considers the number and quality of papers published and also the impact factor of the journal is studied. Surendra[2] carried out a productometric analysis of National Research Centre for Soybean, Indore for the period 1987-2001 in terms of number of research

articles produced by its scientists, average number of papers per year, types of documents publishing the papers along with names of the journals, subject and language distribution. Sudhier[3] conducted a case study of the trends in authorship pattern and collaborative research in physics with a sample of 11,412 journals and 1,328 book citations appended in the physics doctoral dissertations awarded by the Indian Institute of Science, Bangalore during 1999-2003 and found that team research is preferred in the field of physics rather than solo research and authorship collaboration is more in journal articles than in books. Sevukan[4] explains research output in plant sciences of the faculties in central universities of India by analysing a total of 348 bibliographic records of plant sciences retrieved from ISI Science Citation Index – Extended (SCIE) for a period of 10 years from 1997 to 2006 by year, document type, authorship pattern, and collaboration pattern at different levels viz., international, national, and local. Mallinath[5] portrayed the growth, contribution and impact of research carried out by the scientists of University of Mysore in science and technology and pointed out the patterns of communications of university scientists and studied the extent of concentration and scattering of their research output in different journals. Mani[6] analysed a total of 2603 research articles published by the scientists of Central Potato Research Institute (CPRI) during 1991 to 2007 and authorship pattern and found that the degree of collaboration among the authors is high and further indicated that no uniform pattern of literature growth is seen. Akakandelwa[7] provides an informetric analysis of 220 papers published by academic faculty at the University of Zambia from 2002 to June 2007, downloaded from the Thomson Reuters database and analysed authorship patterns and collaboration. It has been found that the degree of collaboration varied from one discipline to another and collaboration was more intensified in the applied sciences. Further the results confirm that the patterns of collaboration between UNZA researchers and foreign researchers fit the Lotka Law of distribution. Sudhier[8] carried out a study based journals cited by the physicists at University of Kerala to examine the applicability of Bradford's law of scattering on a sample of 303 journals containing 2655 citations collected from 12 doctoral theses during the period 2004-08. Gupta[9] described the management and role of higher education in India, the type and growth of higher

education and its priorities as listed in the current 11th Five-Year Plan of Government of India through his paper and also stressed the need for ranking Indian universities. The article focuses on new methodology of ranking of top 50 productive Indian universities using publications, citations and international collaborative publication data. The factors affecting productivity and quality of research in Indian universities were identified and indicated various methods employed for ranking universities.

The paper by Sangam[10] attempts to study the performance of Karnataka State Universities research output during 2000-2009 by analyzing productivity and impact on Universities under broad subject areas and departments and identifies and evaluates the characteristics of collaboration, prolific authors, and research communication in productive journal, Impact Factor and h-index. Branco[11] analyzed the effect of university research centers on the productivity and collaboration patterns of university faculty and based on an analysis of longitudinal bibliometric data. The results from this case study demonstrated affiliation with the centers to be effective at enhancing overall productivity as well as at facilitating cross-discipline, cross-sector, and inter-institutional productivity and collaborations. Puuska[12] examined the effects of a scholar's position and gender on publishing productivity in several types of scientific publications: monographs, articles in journals, articles in edited books, and articles in conference proceedings of University of Helsinki, Finland, during the period 2002–2004 and shows that professors are the most productive, PhDs publish more than non-PhDs, and men perform better than women, when other scholarly characteristics are controlled for. These differences are greater for monographs and articles in edited books than for articles in journals.

Bandyopadhyay[13] mentions the result of the study of references appended to 92 Doctoral theses submitted to the Departments of Mathematics, Physics, Mechanical engineering, Philosophy and Political science, Burdwan University, India, from 1981 to 1990. Extent of multi-authorship, degree of collaboration and their change with time were studied. Gupta and Sangam[14] attempted to study the performance of Karnatak University in terms of its research output during 1999-2008 including the number of papers published annually, its growth rate, international collaborative publication share and major collaborative publications share and major

collaborative partner countries, citation quality and impact of publications. Prathap[15] analyzed the performance of education and research institutes in India in medical and allied sciences during 1999-2008, based on their research output, using robust quantitative and qualitative indicators which gave a more rational procedure for ranking their research performance using the data is collected from the SCOPUS database. The results specify that the overall ranking of top 30 colleges give an assessment of how the medical higher education is performing as generators of new knowledge. Matthews[16] studied publication productivity of physics teachers of South African universities during 2009-2011 based on the data retrieved from departmental websites and Thomson Reuters' Web of Science with the objective to find typical ranges of two measures of individual productivity: number of papers and sum of author share, where author share per n-author paper is 1/ n author units. Productivity of South African professors was similar to that of a sample of USA professors in a comparable mid-ranked bracket in the Shanghai Jiao Tong world ranking of universities, and about half that of professors in the six top-ranked departments in the world. There have been many studies, which have explored the scientometric application of various institutions including universities.

The review of literature reflects that there were not many studies based on universities in Kerala especially in the area of faculty publication productivity. Therefore this paper attempts to study and analyse the publication productivity of science faculty members of universities in Kerala.

Scope and limitations

As a higher learning institute, major missions of a university is imparting knowledge and carrying out research in prime areas which is a concern not only to universities themselves, but also to the government as well as the public. Different types of performance evaluation have been proposed and discussed in the literature, with the aim of pushing universities to pursue excellence and the performance of a university is the aggregation of the performance of all of its faculty members. To evaluate the publication productivity of a university, it suffices to evaluate the publication productivity of individual faculty members and to collectively of all faculty members, no matter which department these faculty members are affiliated with.

For the present study, the science departments of three general Universities in Kerala such as University of Kerala (UOK), Mahatma Gandhi University (MGU) and University of Calicut (UOC) is considered for five years from 2005 to 2009. The present study focuses on faculty publications only and other staff and students are not considered and further only journal publications are considered for the study. Analysis was conducted using MS Excel for tabulation and calculation.

Objectives of the study

- To find out year-wise distribution of journal articles;
- To find out designation and experience wise distribution of articles;
- To analyse the authorship pattern;
- To find out the Degree of Collaboration; and
- To examine the fitness of Lotka's Inverse Square Law

Methodology

The main objective of the study is to make an assessment in quantitative terms with respect to the publications of the faculty members who belong to science departments of the universities in Kerala during 2005 to 2009. Mainly the journal articles of three universities viz., University of Kerala (UoK), Mahatma Gandhi University (MGU) and University of Calicut (UoC) were considered for the study. The bibliographic details were collected by consulting the annual reports and websites of the concerned universities. The personal details of the faculty members such as name, age, date of joining the service etc., were collected through questionnaires which were distributed directly to the faculty members. The collected data were recorded in MS Excel and subjected to further analysis to meet the objectives using scientometric techniques.

Year-wise distribution of journal articles

Being the primary source of information journals transmit embryonic opinions and thoughts which is considered as the precursor of many inventions and discoveries, especially in science disciplines. The faculty members of the departments under study contributed papers mostly in journals and conference proceedings. In UoK there are 966 journal article contributions while in MGU and UoC there are 635 and 734 journal article contributions during the study period (Table 1).

The year-wise breakup shows that in UoK, there are 238 (25%) contribution which is the highest during the period of study and it is observed that contributions are less in 2005 i.e. 129 (13%). In the year 2006, 2008 and 2009 there were 181 (19%), 220 (23%) and 198 (20%) article contributions. In MGU, maximum number of contributions was in the year 2007 i.e. 154 articles (24%) and minimum contribution was in the year 2005 i.e. 90 (14%) articles. In 2006, 2008 and 2009 there were 133 (21%), 131 (21%) and 128 (20%) article contributions in MGU. Maximum number of article contributions in UoC were in the year 2009 i.e. 170 (23%) and minimum contribution was in the year 2005 i.e. 133 (15%). In the year 2006 there were 157 (21%) contribution of journal articles while in 2007 and 2008 there were 126 (17%) and 168 (23%) of contributions respectively.

Designation and experience wise distribution of articles

The designation-wise break-up shows that there are three categories such as Lecturer, Reader and Professor. According to Table 2, designation-wise breakup of publications indicates that majority of contributions are by Professors. In UoK, designation-wise distribution shows that Professors contributed 571 articles while Readers and Lecturers contributed 168 and 227 papers respectively. In MGU, out of 635 journal papers 380 were contributed by Professors while Lecturers and Readers contributed 117 and 138 papers respectively. In UoC also Professors contributed 452 papers which are the highest while Lecturers and Readers contributed 75 and 207 papers during the period of study.

The designation-wise analysis indicates that Professors contribute more publications than other two categories. The reason may be the increase of the absolute number of senior positions in departments during this period might have exceeded that of junior positions. On the other hand, senior faculty members might have become more active in initiating and guiding research. Since the Professors guide more number of research scholars, the number of co-authored papers will be high. A study conducted by Drenth[17] about the authorship of *British Medical Journal* indicates an increase in the productivity of senior scientists. Here, the designation-wise analysis indicates that Professors contributed more publications than other categories. Even though Professors contributed more number of articles, the ANOVA test shows a negative correlation between the designation and number of contributions and it can be concluded that there is no significant difference between designation and number of article contributions.

Table 1—Year-wise growth of journal articles

University	Year	Journal articles	%
University of Kerala	2005	129	13
	2006	181	19
	2007	238	25
	2008	220	23
	2009	198	20
	Total	966	100
Mahatma Gandhi University	2005	90	14
	2006	133	21
	2007	154	24
	2008	131	21
	2009	128	20
	Total	635	100
University of Calicut	2005	113	15
	2006	157	21
	2007	126	17
	2008	168	23
	2009	170	23
	Total	734	100

Table 2—Designation-wise distribution of journal articles

University	Designation	No. of articles	Mean	Std. Dev.	No. of teachers	ANOVA	p
UoK	Lecturer	227	10.81	10.90	22	1.16	0.322
	Reader	168	21.00	30.11	9		
	Professor	571	19.03	23.71	30		
	Total	966					
MGU	Lecturer	117	11.70	13.76	12	1.84	0.174
	Reader	138	12.45	12.01	13		
	Professor	380	25.33	27.52	15		
	Total	635					
UoC	Lecturer	75	6.25	5.08	17	1.64	0.202
	Reader	207	12.18	11.25	21		
	Professor	452	14.16	15.37	32		
	Total	734					

Table 3—Experience-wise distribution of journal articles

University	Experience (in years)	Articles	Mean	Std. Dev.	No. of teachers	ANOVA	p
	<10	323	12.42	13.07	28		
UoK	10 - 19	175	35.00	36.04	5	2.51	0.090
	>=20	468	16.71	23.14	28		
	Total JA	966					
	<10	141	12.82	14.12	15		
MGU	10 - 19	225	17.23	15.42	13	0.59	0.558
	>=20	269	22.42	30.01	12		
	Total JA	635					
	<10	130	6.19	5.21	27		
UoC	10 - 19	288	18.00	12.65	19	4.32*	0.018
	>=20	316	13.21	16.03	24		
	Total JA	734					

In UoK, it is found from the Table 3 that those faculty members with experience greater than or equal to 20 contributed 468 articles in journals while the faculty members with experience less than 10 years contributed 323 articles. Lowest contribution is provided by the faculty members with experience between 10 to 19 years. In MGU, the faculty members with experience greater than or equal to 20 contributed 269 articles which is followed by faculty members having experience between 10 to 19 years with 225 articles. In UoC the faculty members with experience greater than or equal to 20 are having 316 articles while those faculty members with experience between 10 and 19 years and less than 10 years contributed 288 and 130 journal articles respectively.

The ANOVA test shows a significant level of difference i.e.0.05 in the case of UoC which shows the relation between the experiences and number of article contribution, but in other universities although there is difference in the number of contribution, but it is not statistically significant. The correlation between experience and number of publications was less for the present data. The introduction of Academic Performance Index (API) based promotion by UGC which also provides points to number of publications in journals as well as conferences accelerated the publication productivity of junior level teachers also. Meanwhile the reason for decrease in productivity of experienced teachers is due to the additional administrative responsibilities.

Authorship pattern

Usually the articles produced will be a bi-product of some experiment/research conducted by the students as well as teachers. In scientific disciplines,

Table 4—Authorship pattern of journal articles

University	No. of authors	No. of articles	Percent	Cumulative percent
	1	75	7.8	7.8
	2	379	39.2	47.0
UoK	3	285	29.5	76.5
	>3	227	23.5	100.0
	Total	966	100	
	1	118	18.6	18.6
	2	133	20.9	39.5
MGU	3	105	16.5	56.1
	>3	279	43.9	100
	Total	635	100	
	1	130	17.7	17.7
	2	267	36.4	54.1
UoC	3	182	24.8	78.9
	>3	155	21.1	100
	Total	734	100	

team research is more prevalent and hence collaborative papers are common. Here in this study an attempt is made to analyse and plot the authorship-wise distribution to differentiate between single and multi-authorship papers.

From the Table 4 it is clear that the percentage of multi-authored papers is high when compared against single authored papers. In total there are 323 (13.8%) single authorship papers and 779 (33.4%) two-authored papers. The papers authored by three and more than three joint authors are 572 (24.5%) and 661 (28.3%) respectively. The analysis reveals that in UoK, 2-authored papers comprised highest 39.2% of total 966 articles and next comes 3-authored and more than 3 authored papers with 29.5% and 23.5% respectively. Single authored papers are less in UoK i.e. 7.8%.In MGU papers with more than 3 authors are

highest in number i.e., 276 (43.9%) which is followed by 2-authored papers i.e. 133 (20.9%) and the single authored papers are 118 (18.6%). There are 105 (16.5%)3-authored papers. In the case of UoC, 2-authored papers dominate with 267 (36.4%) which is followed by 3-authored papers i.e. 182 (24.8%). The papers authored by more than three authors constitute 155 papers i.e. (21.1%). Out of 734 papers from UoC, only 130 (17.7%) are having single authorship.

A study on physics literature by Sudhier[18] revealed that 2-authored papers are highest in number compared to others. In the present study, forUoK and UoC the number of 2-authored papers is more and in MGU the three authored papers are more in number.

Degree of Collaboration

According to Harande[19] author collaboration is the act whereby two or more people agree to execute a certain project, be it intellectual or non-intellectual. Subramanyam[20] proposed the Degree of Collaboration as a measure of the strength of collaboration in a discipline. The Degree of Collaboration among authors is the ratio of the number of collaborative publications to the total number of publications published in a discipline during certain period of time, which can be calculated for both publications and citations.

The mathematical expression of the formula is

$$C=\frac{Nm}{Nm+Ns}$$, where C = Degree of collaboration, Nm = Number of multi-authored papers and Ns = Number of single authored papers.

In total there are 323 single authored papers and 2012 multi-authored papers. Therefore DC is calculated as $C=\frac{323}{323+2012}=.014$. The Degree of Collaboration for different subjects ranges from 0.01 and 0.99. Table 5 provides the university-wise Degree of Collaboration.

Designation-wise Degree of Collaboration

Based on Table 6, in UoK, Readers collaborate more i.e., the DC among Readers is 0.97. The DC of Professors is 0.96 and as of Lecturers is 0.80. In MGU, the DC among the Professors is more when compared to Readers and Lecturers. The DC among Professors is 0.92 while the DC of Readers is 0.72 and Lecturers is 0.62 respectively. In UoC the DC among Readers is more i.e. 0.84 while the DC of Lecturers and Professors is 0.73 and 0.83 respectively.

The correlation between designation and Degree of Collaboration is provided in Fig. 1. It is found that in MGU the DC of Professors are high and in UoK and MGU the DC of Professors and Readers are almost same.

Experience-wise Degree of Collaboration

According to the Table 7, the faculty members with experience between 20 and 25 years are having maximum DC i.e. 0.92 while those with experience between 5 to 10 years and greater than or equal to 25 are having DC 0.89. The faculty members with 10 to 15 and 15 to 20 years of experience are having DC 0.86. The faculty members of experience between 5 to 10 years are having the Degree of Collaboration 0.71 which is a low score compared to others.

The relationship among DC and experience is plotted in Fig. 2 from which it is evident that the faculty members with experience of 20 to 25 years are having more DC and the DC among the faculty members less than 5 years of experience are less when compared to other faculty members under observation.

Table 5—University-wise Degree of Collaboration

University	Single author	Two authors	Three authors	>Three authors	Total	DC
UoK	75	379	285	227	966	0.93
MGU	118	133	105	279	635	0.84
UoC	130	267	182	155	734	0.85

Table 6—Designation vs. Degree of collaboration

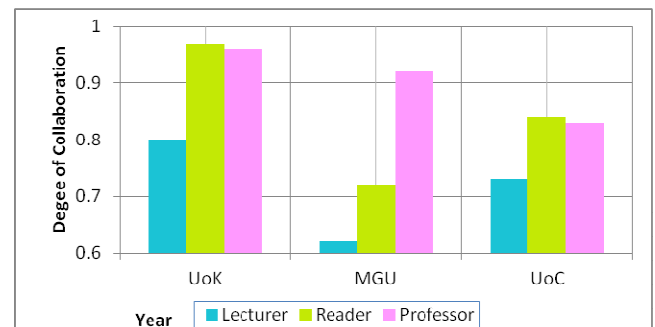| Designation	Single author	Two authors	Three authors	>Three authors	Total	DC
Lecturer	107	129	92	85	306	0.74
Reader	86	223	109	129	461	0.84
Professor	130	427	371	447	1245	0.91
Total	323	779	572	661	2012	0.86

Fig. 1—Degree of collaboration vs. designation

Table 7—Experience-wise Degree of collaboration

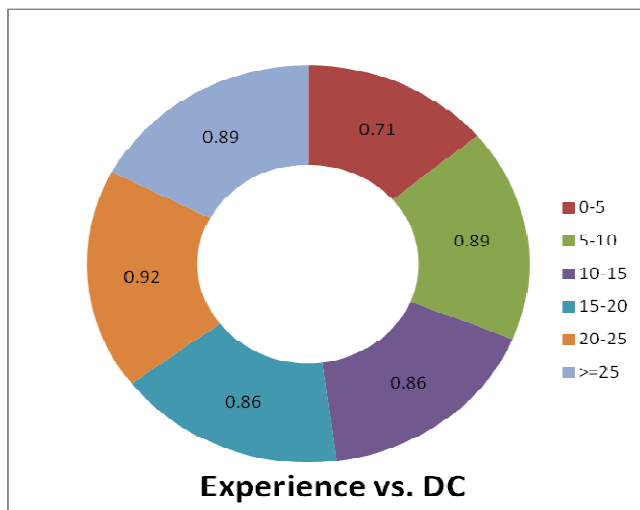| Experience (in yars)	Single author	Two Authors	Three Authors	>Three authors	Total	DC
0-5	100	91	77	80	248	0.71
5-10	32	94	86	67	247	0.89
10-15	66	150	107	162	419	0.86
15-20	40	142	71	30	243	0.86
20-25	61	232	189	244	665	0.92
>=25	24	70	42	78	190	0.89
Total	323	779	572	661	2012	0.86

Fig. 2—Degree of collaboration vs. experience

Lotka's Inverse Square Law

While examining the distribution frequencies of scientific productivity of chemistry and physics from the publications covered by Chemical Abstracts and Auerbach's Geschichtstafln der Physik, Lotka[21]observed a quantitative relation among the authors and their scientific production. It states that, "… the number (of authors) making n contributions is about $1/n^2$ of those making one; and the proportion of all contributors, that make a single contribution, is about 60 percent", which means that out of all the authors in a given field, 60% will have only one publication, 15% will have two publications and 7% of authors will have 3 publication and so on. In other words, in a particular topic, for every 100 authors whose contribution is single article, there will be 25 authors with two articles, 11 authors with three articles etc. General expression of Lotka's law is $x^n y = k$

The productivity of the faculty members of UoK, MGU and UoC is tested to find the conformity with the Lotka's inverse square law using Pao's method[22]and it is tested by K-S goodness-of-fit test.

Table 8—Calculation of 'n'

x	g(x)	ln (x)	ln (gx)	ln (x)* ln (gx)	ln (x)* ln (x)
1	14	0.000	1.146	0.000	0.000
2	16	0.301	1.204	0.091	0.362
3	9	0.477	0.954	0.228	0.455
4	7	0.602	0.845	0.362	0.509
5	6	0.699	0.778	0.489	0.544
6	6	0.778	0.778	0.606	0.606
7	6	0.845	0.778	0.714	0.658
8	4	0.903	0.602	0.816	0.544
9	6	0.954	0.778	0.911	0.743
10	7	1.000	0.845	1.000	0.845
Total	81	6.56	8.71	5.22	5.26

The 'n' is determined using Linear Least Square (LLS) regression method.

To determine the 'n' value, the LLS method is followed using the formula (Table 8)

$$n = \frac{[N\sum(\text{In } x.\text{In } g(x)) - \sum \text{In } g(x)\sum \text{Inx}]}{[N\sum(\text{In } x^2) - (\sum \text{Inx}^2)]},$$ where

N=10.

By substituting the values in this equation the value of 'n' is calculated as:

$$n = \frac{10 \times 6.56 - 8.71 \times 6.56}{10 \times 5.26 - (6.56)^2} = -0.49.$$ Taking absolute

value of -0.42 i.e. $|-0.49| = 0.49$

By substituting the values in the following equation, the value of 'c' is determined. For this purpose, 'n' value is provided as 0.49 and 'p' is assumed to be 20.

$$C = \frac{1}{\sum_{x=1}^{p-1} 1/x^n + 1/x^n 1/(n-1)(p^{n-1})^{+\frac{1}{2}pn+} n/24 \times (p-1)^{n+1}}$$

, i.e. C= -0.84

Taking absolute value of -0.84 i.e. 0.84

By replacing the values of 'n' and 'c' in Lotka's model $g(x)=kx-n$ in the present table, the fitness of Lotka's law to the present data set is determined by K-S statistical Test. The difference between fractional values of observed and expected frequencies has been calculated and provided in the Table 9. It is found from the table that the maximum deviation Dmax is found to be 20.093. The critical

Table 9—K-S test on observed and theoretical distribution of authors

No. of papers (x)	No. of authors (g(x))	Observed frequency (FOF)	Observed cumulative (CFOF)	Theoretical freq (FEF)	Theoretical cum freq (CFEF)	Diff (DOECF)
1	14	0.095	0.095	-1.060	-1.060	1.155
2	16	0.109	0.204	-0.849	-1.909	2.113
3	9	0.061	0.265	-0.746	-2.655	2.920
4	7	0.048	0.313	-0.680	-3.335	3.648
5	6	0.041	0.354	-0.633	-3.968	4.322
6	6	0.041	0.395	-0.597	-4.566	4.960
7	6	0.041	0.435	-0.569	-5.135	5.570
8	4	0.027	0.463	-0.545	-5.680	6.142
9	6	0.041	0.503	-0.525	-6.204	6.708
10	7	0.048	0.551	-0.507	-6.712	7.263
11	4	0.027	0.578	-0.492	-7.204	7.782
12	5	0.034	0.612	-0.479	-7.682	8.295
13	1	0.007	0.619	-0.466	-8.149	8.768
14	4	0.027	0.646	-0.456	-8.604	9.251
15	6	0.041	0.687	-0.446	-9.050	9.737
16	3	0.020	0.707	-0.437	-9.486	10.194
17	3	0.020	0.728	-0.428	-9.915	10.642
18	3	0.020	0.748	-0.420	-10.335	11.083
19	1	0.007	0.755	-0.413	-10.748	11.503
20	2	0.014	0.769	-0.406	-11.155	11.923
21	3	0.020	0.789	-0.400	-11.555	12.344
22	2	0.014	0.803	-0.394	-11.949	12.752
23	2	0.014	0.816	-0.389	-12.338	13.154
24	1	0.007	0.823	-0.383	-12.721	13.544
26	1	0.007	0.830	-0.374	-13.095	13.925
27	1	0.007	0.837	-0.369	-13.464	14.301
28	1	0.007	0.844	-0.365	-13.829	14.672
29	2	0.014	0.857	-0.361	-14.190	15.047
30	3	0.020	0.878	-0.357	-14.547	15.424
33	1	0.007	0.884	-0.346	-14.893	15.777
34	2	0.014	0.898	-0.343	-15.236	16.134
35	1	0.007	0.905	-0.340	-15.576	16.480
36	1	0.007	0.912	-0.337	-15.912	16.824
38	1	0.007	0.918	-0.331	-16.243	17.162
40	1	0.007	0.925	-0.326	-16.569	17.494
44	1	0.007	0.932	-0.316	-16.885	17.817
46	2	0.014	0.946	-0.311	-17.196	18.142
50	2	0.014	0.959	-0.303	-17.499	18.458
55	1	0.007	0.966	-0.294	-17.793	18.759
56	1	0.007	0.973	-0.292	-18.085	19.058
60	1	0.007	0.980	-0.286	-18.371	19.351
86	1	0.007	0.986	-0.255	-18.626	19.613
109	1	0.007	0.993	-0.236	-18.862	19.856
118	1	0.007	1.000	-0.230	-19.093	20.093

value of D in Kolmogorov-Smirnov (K-S) test at 0.05 and 0.01 levels are 0.1778 and 0.2131 respectively, while the calculated value of D is 20.093, which means the calculated value of D does not fall within the critical value of D. Therefore, the author productivity distribution of faculty members of UoK does not follow the Lotka's Inverse Square law.

Over many years, Lotka's law of scientific productivity has been extensively tested in the Library and Information Science field, due to the application
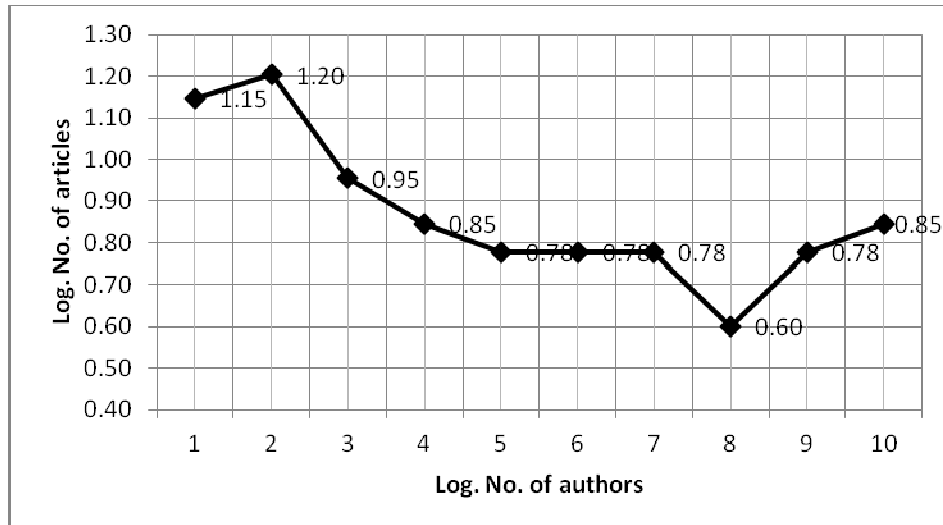
Fig. 3—Log plot of No. of authors vs. No. of articles

of varying methods the obtained results of the studies are uncertain. This study finds that literature output of the teachers of Universities in Kerala does not conform to Lotka's law. Graphical representation of Lotka's distribution with number of authors in X-axis and number of articles in Y-axis is provided in Fig. 3.

Findings

The year-wise distribution of journal articles shows an increasing tendency, since in 2005 the articles were very low and in 2009 it is high. In UoK, and MGU highest number of article contribution is in 2007 while in UoC, it is in 2009. Designation-wise distribution of article contribution shows that Professors contribute more papers than Lecturers and Readers. But there is no statistically significant difference between the number of article contribution and designation. Experience-wise analysis indicates that with the increase in experience the rate of article contribution also increases. The ANOVA test shows a significant level of difference in UoC which shows the relation between the experiences and number of article contribution, but in other universities although there is difference in the number of contribution, but it is not statistically significant. Authorship pattern analysis shows that single authored papers are less compared to multi-authored papers in all the universities under investigation. In UoK and UoC, two-authored papers are more while in MGU there is a domination of more than three authored papers.

Calculated Degree of Collaboration shows that it is high in UoK compared to MGU and UoC which indicates that more number of collaborative papers is

from UoK. Designation-wise Degree of Collaboration shows that Professors are having a high Degree of Collaboration which indicates the increase in the age results in more collaborative papers. It is found that in MGU, the DC of Professors is high and in UoK and UoC the DC of Professors and Readers is almost same. Experience-wise distribution of DC indicates that DC increases with the increase in experience. Faculty members with experience of 5 to 10 years in MGU are having more DC and the DC among the faculty members of UoK is more when compared to other universities under observation. Since the calculated value of difference 'D' does not fall within the critical value of D, the Lotka's distribution is rejected for the present data set.

Conclusion

The paper examines the authorship pattern, Degree of Collaboration and the conformity of Lotka's law in the present data set. Bibliometrics are now used in quantitative research assessment exercises of academic output which is starting to threaten practice based research. This study evaluates publication productivity of faculty members of universities with special reference to journal articles. Teacher's participation in collaborative research has been taken into account and publication and productivity pattern have been calculated. It is clear from the study that multi-authorship is prevalent among teachers in universities. Quantity and quality of the publications are one of the major factors considered for ranking of universities and the publication output of the faculty members has a major role in this especially in science

departments of the universities. Universities can attain visibility, prestige, and credibility in the broader academic community by producing high quality research and this in turn enhances the reputation of the universities and provides a greater opportunity for attracting better students and faculty.

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