

A Bibliometric Analysis of Authorship and Collaboration Trend In Nature Nanotechnology

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Abstract: The aim of the present study is to analyze the authorship pattern and collaboration trends in the Nature Nanotechnology during the first ten years period. Bibliographic records of the source journal are obtained from the Web of Science core collection. A total of 2060 articles published in the first ten years and those are analyzed in terms of authorship pattern. Various bibliometric tools such as collaborative co-efficient, degree of collaboration and co-authorship index are employed. Further, applicability of Lotka's law is tested. The results show that 73% of total publications were collaborative in nature. The collaboration co-efficient has been arrived at 0.58 and collaboration index is calculated to 6.76 for the first ten years. The value of Co-Authorship Index (CAI) for co-authored publications with more than three authors shows an increasing trend from first five year block period to another while for publications with few authors (<3), it reveals a declining trend.

1. INTRODUCTION

Scientists have too many choices of journals to read and refer, and the evaluation of the performance of a journal was deemed necessary to indicate the impact and contribution in its respective field (Rice 1983). Generally, journals play an important role in disseminating the research findings among the scientific community.

Nature Nanotechnology is a peer-reviewed journal with an impact factor of 35.267 in 2015 and ranked 1st among the 83 journals indexed under the category of nanoscience and nanotechnology. It is a multidisciplinary journal that publishes the high quality refereed papers in all aspects of the nanoscience and nanotechnology. Major research areas covered in the journal are:

- Carbon nanotubes and fullerenes

- Computational nanotechnology
- Electronic properties and devices
- Environmental, health and safety issues
- Molecular machines and motors
- Molecular selfassembly
- Nanobiotechnology
- Nanofluidics
- Nanomagnetism and spintronics
- Nanomaterials
- Nanomedicine
- Nanometrology and instrumentation
- Nanoparticles
- Nanosensors and other devices
- NEMS
- Organic–inorganic nanostructures
- Photonic structures and devices
- Quantum information
- Structural properties

- Surface patterning and imaging
- Synthesis and processing

In addition to primary research, Nature Nanotechnology also publishes review articles, news and views, research highlights about important papers published in other journals, commentaries, book reviews, correspondence, and articles about the broader nanotechnology picture — funding, commercialization, ethical and social issues, and so on. Unlike other journals, it has no external editorial board. Instead, all editorial decisions are made by a team of fulltime professional editors, who are PhD level scientists.

2. RELATED LITERATURE

Several studies have been conducted to examine the authorship pattern of individual journals by various authors. Few of the related studies have been reviewed and presented here.

Koseoglu (2016) analyzed the growth and structure of authorship in the Strategic Management Journal published between 1980 and 2014. He found that the authorship pattern of the SMJ shows multi-authored articles dominated solo work.

Goyal et al. (2013) examined the authorship pattern and collaborative research trends in the Journal of Chemistry Section-B. They found that only 3% of publications were single authored in a ten years period.

Ramakrishnan and Thavamani (2015) analyzed the authorship pattern and collaborative research in the journal Gastroenterology. They found that the value of Co-Authorship Index (CAI) for single authored paper shows a declining trend from one block year period to another block.

Velmurugan and Radhakrishnan (2015) examined the authorship pattern in the DESIDOC Journal of Library and Information Technology from 2007 to 2012. They found that more than 40% of publications were single authored.

Santhakarthikeyan et al. (2014) analyzed the author productivity in the Indian Journal of Cancer and found that the average number of authors per paper was 5.47.

Rajgoli et al. (2015) analyzed the authorship pattern and degree of collaboration in the Journal of Spacecrafts and Rockets. They tested Lotka's law of scientific productivity and found that the author productivity was confirmed only partially.

Arya (2012) examined the authorship pattern and collaborative research trends among the publications in the Indian Journal of Veterinary Medicine published between 1999 and 2007. The results showed that the average number of authors varied from 2.92 to 4.08.

3. OBJECTIVES

The specific objectives of the present study are:

- To examine the authorship pattern
- To study the proportion of single-authored against multi-authored papers
- To determine the degree of collaboration
- To study the author productivity
- To test the applicability of Lotka's law

4. DATA AND METHODOLOGY

Bibliographic records of the source journal Nature Nanotechnology are obtained from the Web of Science core collection. All the articles published in the first ten years (from 2006 to 2015) of Nature Nanotechnology were analyzed in terms of authorship pattern. The retrieved data was exported to MS-Excel for further analysis. Manual coding has been done to determine the number of authors involved in a publication. Various bibliometric tools such as Collaboration Co-efficient, Degree of Collaboration, Collaboration Index and Lotka's law were employed.

5. RESULTS AND DISCUSSION

Table 1 Authorship pattern

| #Authors | # Publications | % |
|----------|----------------|-------|
| 1 | 568 | 27.57 |
| 2 | 270 | 13.11 |
| 3 | 123 | 5.97 |
| 4 | 131 | 6.36 |
| 5 | 168 | 8.16 |
| 6 | 125 | 6.07 |
| 7 | 126 | 6.12 |
| 8 | 95 | 4.61 |
| 9 | 92 | 4.47 |
| 10 | 64 | 3.11 |
| >10 | 192 | 9.32 |
| Anon | 106 | 5.15 |
| Total | 2060 | 100 |

Table 1 reveals the trend of authorship among the contributing authors in Nature Nanotechnology. There are 106 (5.15%) publications by anonymous. Out of 2060 publications, 568 (27.5%) are single authored and remaining by co-authors with two or more authors. Interestingly, the highest percentage of publications (27.5%) was contributed by single author. Similar trend has been observed in Journal of Info Literacy (Panda et al. 2013) and Journal of Intellectual Property Rights (Swain and Panda 2012). It can be attributed that this journal publishes more number of publications as Editorial Material and News Item than regular articles and reviews: it is not provided in the data analysis. Unlike other fields, nearly 10% of publications were contributed with more than 10 authors.

Collaborative Co-efficient

The strength of collaboration among the contributing authors is measured with following formula suggested by Ajiferuke et al. (1988).

$$CC = 1 - \left(\sum_{j=1}^k \frac{1}{j} * \frac{F_j}{N} \right) \quad (1)$$

where

F_j= the number of articles with "j" author

J= articles (one author, two authors, three authors...)

N= the whole number of authors in an article.

According to Ajiferuke et al. (1988), collaboration co-efficient is a number between 0 and 1. CC tends to 0 indicates the domination of single authored publications and near to 1 indicates the domination of multi-authored publications.

Table 2 Collaborative co-efficient

| Year | Number of authors | | | | | | CC |
|------|-------------------|----|----|----|----|-----|------|
| | 1 | 2 | 3 | 4 | 5 | >5 | |
| 2006 | 23 | 8 | 0 | 3 | 6 | 12 | 0.44 |
| 2007 | 73 | 30 | 12 | 15 | 16 | 49 | 0.48 |
| 2008 | 71 | 28 | 12 | 14 | 16 | 52 | 0.49 |
| 2009 | 73 | 25 | 23 | 15 | 19 | 63 | 0.52 |
| 2010 | 42 | 40 | 12 | 14 | 29 | 71 | 0.63 |
| 2011 | 42 | 22 | 10 | 12 | 22 | 73 | 0.59 |
| 2012 | 43 | 28 | 16 | 17 | 16 | 72 | 0.58 |
| 2013 | 70 | 33 | 12 | 10 | 15 | 94 | 0.54 |
| 2014 | 67 | 29 | 14 | 18 | 15 | 102 | 0.57 |
| 2015 | 64 | 27 | 12 | 13 | 14 | 106 | 0.58 |
| Mean | | | | | | | 0.54 |

For this analysis, the entire data has been grouped into six blocks such as single, two, three, four, five and more than five authored publications. Accordingly, the year-wise authorship pattern and related collaborative co-efficient values are provided in table 2. There was an increasing trend during the first five year period (i.e. 0.44 in 2006 to 0.63 in 2010) and fluctuating trend during the second five year period (i.e. 0.59 in 2007 to 0.58 in 2015) in the value of collaborative co-efficient.

The average value of CC reveals the average level of collaboration among the authors.

Degree of Collaboration

To examine the extent of research collaboration in the study, the following formula suggested by Subramanyam (1983) has been adopted.

$$DC = N_m / N_m + N_s \tag{2}$$

where

- DC = degree of collaboration
- N_m = number of multiple authored papers
- N_s = number of single authored papers

Accordingly, the average degree of collaboration is calculated to 0.72 and is quite significant. The highest value was in the year 2010 with 0.81 and lowest in 2006. This result indicates the prevalence of team research in the field of nanotechnology. Similar trend has been observed in the Journal of Informetrics (Das 2013).

Table 3 Degree of Collaboration

| Year | No. Single Authored Papers | No. of Multi Authored Papers | DC |
|------|----------------------------|------------------------------|------|
| 2006 | 23 | 32 | 0.58 |
| 2007 | 73 | 134 | 0.65 |
| 2008 | 71 | 134 | 0.65 |
| 2009 | 73 | 160 | 0.69 |
| 2010 | 42 | 181 | 0.81 |
| 2011 | 42 | 143 | 0.77 |
| 2012 | 43 | 154 | 0.78 |
| 2013 | 70 | 174 | 0.71 |
| 2014 | 67 | 192 | 0.74 |
| 2015 | 64 | 188 | 0.75 |
| Avg. | | | 0.72 |

Collaboration Index

Collaboration Index (CI) is measured by dividing the total number of authors of multi-authored articles with the total number of multi-authored articles (Elango and Rajendran, 2012). The CI ranges between 5.84 in the year 2007 and 7.56 in the year 2015 with an average of 6.76 which suggests that the research team consists of 6 authors. The average value is 4 times higher than the observed value in Strategic Management Journal (Koseoglu 2016).

Table 4 Average authors per paper

| Year | No. of Multi Authored Papers | Total No. of Authors | CI |
|-------|------------------------------|----------------------|------|
| 2006 | 29 | 189 | 6.52 |
| 2007 | 122 | 713 | 5.84 |
| 2008 | 122 | 732 | 6.00 |
| 2009 | 145 | 904 | 6.23 |
| 2010 | 166 | 995 | 5.99 |
| 2011 | 139 | 1005 | 7.23 |
| 2012 | 149 | 971 | 6.52 |
| 2013 | 164 | 1225 | 7.47 |
| 2014 | 178 | 1338 | 7.52 |
| 2015 | 172 | 1300 | 7.56 |
| Total | 1386 | 9372 | 6.76 |

Pattern of co-authorship

In order to examine the changing pattern of co-authorship, the following formula suggested by Garg and Padhi (2001) is used.

$$CAI = \frac{N_{ij} / N_{io}}{N_{oj} / N_{oo}} \times 100 \tag{3}$$

where,

CAI = Co-Authorship Index

N_{ij} = Number of papers having j authors in block i

N_{io} = Total output of block i

N_{oj} = Number of papers having j authors for all blocks

N_{oo} = Total number of papers for all authors and all blocks

$j = 1, 2, 3, 4 \geq 5$

CAI = 100 implies that co-authorship corresponds to the world average, CAI > 100 reflects higher than the world average and CAI < 100 reflects lower than the world average in a particular type of authorship.

For this analysis, the entire data has been classified into four blocks such as single, two, three and more than three authored publications. Further, the data has been classified into two five year block period. The calculated results of co-authorship index have been provided in Table 5. It is observed that the value of CAI is in decreasing trend from first five year block to second five year block for single, double and three authored publications whereas increasing trend for publications with more than three authors.

Table 5 Co-authorship index

| Block | Number of authors | | | | Total |
|-----------|-------------------|-----------|----------|-----------|-------|
| | 1 | 2 | 3 | >3 | |
| 2006-2010 | 282 (112) | 131 (109) | 59 (108) | 393 (90) | 866 |
| 2011-2015 | 286 (90) | 139 (92) | 64 (93) | 599 (108) | 1088 |
| Total | 568 | 270 | 123 | 993 | 1954 |

Author Productivity

Lotka's law describes the frequency of publication by authors in a given field (here: Nature Nanotechnology). 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% (Lotka 1926). Lotka's law is stated by the following formula: $xny = c$ where y is the number of authors

with x publications, the exponent n is suggested by a value of 0.6079 and the constant c is suggested by a value of 2. This means that out of all the authors in a given field, about 60% will have just one publication, about 15% will have two publications ($1/2^2$ times 0.60), about 7% of authors will have three publications ($1/3^2$ times 0.60), and so on. The total articles are tabulated in ascending order of author productivity to facilitate the Lotka analysis. The frequency distribution of author productivity is presented in Table 6. Of the 6964 unique author names, 5533 (79.45%) produced one article, 954 (13.7%) produced two articles and so forth. The number of authors who produced more than 10 articles is very low (only 0.13%).

Table 6 Distribution of Author Productivity

| No. of Pubs. | Author (s) | % | Cum % |
|--------------|------------|-------|--------|
| 1 | 5533 | 79.45 | 79.45 |
| 2 | 954 | 13.70 | 93.15 |
| 3 | 272 | 3.91 | 97.06 |
| 4 | 96 | 1.38 | 98.43 |
| 5 | 40 | 0.57 | 99.01 |
| 6 | 25 | 0.36 | 99.37 |
| 7 | 13 | 0.19 | 99.55 |
| 8 | 10 | 0.14 | 99.70 |
| 9 | 4 | 0.06 | 99.76 |
| 10 | 8 | 0.11 | 99.87 |
| 11 | 2 | 0.03 | 99.90 |
| 12 | 3 | 0.04 | 99.94 |
| 14 | 1 | 0.01 | 99.96 |
| 15 | 1 | 0.01 | 99.97 |
| 16 | 1 | 0.01 | 99.99 |
| 41 | 1 | 0.01 | 100.00 |

According to Lotka's law, the generalized formula is $xny = c$ the suggested value of n is 2. The exponent n is calculated by the least square-method using the following formula (Pao, 1985):

Table 7 Calculation of the exponent n

| Pubs. (x) | Authors (y) | X = log (x) | Y = log (y) | XY | XX |
|-----------|-------------|-------------|-------------|------|------|
| 10 | 8 | 1.00 | 0.90 | 0.90 | 1.00 |
| 9 | 4 | 0.95 | 0.60 | 0.57 | 0.91 |
| 8 | 10 | 0.90 | 1.00 | 0.90 | 0.82 |
| 7 | 13 | 0.85 | 1.11 | 0.94 | 0.71 |
| 6 | 25 | 0.78 | 1.40 | 1.09 | 0.61 |
| 5 | 40 | 0.70 | 1.60 | 1.12 | 0.49 |
| 4 | 96 | 0.60 | 1.98 | 1.19 | 0.36 |
| 3 | 272 | 0.48 | 2.43 | 1.16 | 0.23 |
| 2 | 954 | 0.30 | 2.98 | 0.90 | 0.09 |
| 1 | 5533 | 0.00 | 3.74 | 0.00 | 0.00 |
| Total | 6955 | 6.56 | 17.76 | 8.78 | 5.22 |

Table 8 K-S test

| Pubs. | Authors | Observed | Sn(x) | Expected | Fo(x) | D |
|-------|---------|----------|--------|----------|--------|---------|
| 1 | 5533 | 0.7945 | 0.7945 | 0.8512 | 0.8512 | -0.0567 |
| 2 | 954 | 0.1370 | 0.9315 | 0.0971 | 0.9483 | -0.0168 |
| 3 | 272 | 0.0391 | 0.9706 | 0.0273 | 0.9756 | -0.0050 |
| 4 | 96 | 0.0138 | 0.9843 | 0.0111 | 0.9867 | -0.0023 |
| 5 | 40 | 0.0057 | 0.9901 | 0.0055 | 0.9922 | -0.0021 |
| 6 | 25 | 0.0036 | 0.9937 | 0.0031 | 0.9953 | -0.0016 |
| 7 | 13 | 0.0019 | 0.9955 | 0.0019 | 0.9972 | -0.0017 |
| 8 | 10 | 0.0014 | 0.9970 | 0.0013 | 0.9985 | -0.0015 |
| 9 | 4 | 0.0006 | 0.9976 | 0.0009 | 0.9994 | -0.0018 |
| 10 | 8 | 0.0011 | 0.9987 | 0.0006 | 1.0000 | -0.0013 |

$$n = \frac{N \sum XY - \sum X \sum Y}{N \sum X^2 - (\sum X)^2} \quad (4)$$

The values of c and n have been calculated with data available in Table 7. The calculated value of the constant c is 0.8512; the value of n is calculated to 3.1316.

According to Pao (1989), the absolute value of n should be between 1.2 and 3.8, as given by the generalized Lotka's law. The result indicates that n

(=3.1316) is between 1.2 and 3.8 and is matched the reference data by observation.

The K-S goodness-of-fit test was conducted to determine if Lotka's law can be used as a reliable tool to predict author publication productivity from the observed values. Looking at the D column in Table 8, the maximum difference between the cumulative distributions, D-max, is -0.0013. According to K-S test, the threshold value is:

$$1.63/\sqrt{6964} = 0.0195 \quad (5)$$

Here, $D = -0.0013$ which is smaller than the threshold value. The result indicates that the distribution of author productivity is matched by the Lotka's Law. Similar trend has been found in the Strategic Management Journal (Koseoglu 2016).

6. CONCLUSION

The main purpose of this study was to investigate the authorship pattern and collaboration behavior among the authors in the Nature Nanotechnology. Data was gathered from the publications of first ten year from 2006 to 2015. These data were used to gain insights into authorship pattern specifically, collaboration pattern and author productivity. Further, the applicability of Lotka's law was tested. The results of this study reveal some interesting things. The result of this study shows that solo authored publication dominated this high impact journal. It can be attributed that this journal publishes more number of editorial materials and news item than others. The average value of Collaboration Index for the first ten year period is 6.76 which is higher than other journals. According to K-S test, the distribution of author productivity shows that the Lotka's law is applicable. The results of this study can be used for comparison with other high impact journals.

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