Afr. J. Lib, Arch. & Inf. Sc. Vol. 19, No. 1 (2009) 13 - 23

Author Collaboration and Productivity at the University of Zambia, 2002-2007

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Abstract

This paper is an informetric analysis of 220 papers published by academic faculty at the University of Zambia from 2002 to June 2007, downloaded from the Thomson Scientific database. The papers were analysed for authorship patterns and collaboration. The highest number of papers published in a year was 63 in 2006. The average number of publications per year was 36.7, and the highest collaboration coefficient of 0.91 was found in the year 2004. The degree of collaboration varied from one discipline to another. Collaboration was more intensified in the applied sciences. Fifty-four countries collaborated with UNZA faculty in research. The top ten most collaborating countries were USA, England, Japan, Belgium, South Africa, Zimbabwe, Denmark, Norway, Australia, and Sweden. The results confirm that the patterns of collaboration between UNZA researchers and foreign researchers fit the Lotka Law of distribution. The study also established a positive relationship between author productivity and author collaboration. The more collaborative an author is, the more productive that author is. Finally, the study observed a growing collaboration between University of Zambia researchers and other researchers in the Southern African universities.

Keywords

Collaboration, co-authorship, research productivity, universities, Lotka's law, Zambia

Introduction

The University of Zambia (UNZA), established in 1965 by an Act of Parliament, is the largest public university in Zambia. It has nine schools, namely: Agriculture, Education, Mines, Natural Sciences, Engineering, Humanities and Social Sciences, Veterinary Medicine, and Medicine. It also has two directorates and a research institute: the Directorate of Distance Education, the Directorate of Research and Graduate Studies, and the Institute of Economic and Social Research. The University offers both undergraduate and graduate programmes.

Like most universities the world over, UNZA places emphasis on research and publishing, and a long term vision of UNZA has been to be a centre of excellence in research and graduate programmes that would greatly contribute to the dissemination of new knowledge in Zambia. In turn, academics at UNZA are increasingly getting more involved in collaborative research and publishing in local and international journals.

An important research issue in this regard is the nature of the current and evolving patterns of collaborative research and publishing by academics at UNZA. Accordingly, the main objective of this study is to assess the level of partnerships between University of Zambia authors and other scholars in the other institutions in Zambia and abroad.

The specific objectives of this study are to:

1. identify the level of publication productivity of academic faculty at the university.

2. determine levels of collaboration between UNZA and other authors of the publications.
3. determine whether a relationship exists between author collaboration and productivity.
4. verify if Lotka's Law of author productivity applies to Zambian publications.

Literature Review

Lotka's Law of Author Productivity

Lotka investigated the literature output of a sample of chemists, and found that the number of authors who had published a specific number of papers was approximately equal to the inverse square of that number multiplied by the number of authors who had published one paper only, that is:

$$f(n) = \frac{c}{n^{\alpha}}$$

where $f(n)$ denotes the number of authors with n publications (Egghe, 2005). More generally, $f(n)$ can denote the number of sources (authors, journals, word types, etc.) with n items (publications, articles, word occurrences, respectively). C, $\alpha > 0$ are constants. Hence, the equation is a decreasing power law. A purely illustrative example: if 1,000 authors published one paper each on a subject, then c.250 published two papers each, c.111 published three papers each, and so on.

The law has been found to be robust and universal in its applicability, extending beyond the world of scholarly publishing to even describe the productivity of software developers in open source systems (Newby, Greenberg and Jones, 2003). With the isolated exception of a study on Dutch high-energy physics (Kretschmer and Rousseau, 2001), where typically more than 100 authors are recorded on each paper, Lotka's law appears to be a highly resilient and structural feature of intellectual productivity across many different fields.

There is good evidence that frequency of publication correlates significantly with frequency of citation and professional reputation (Merton, 1988); and that being part of a stimulating, privileged intellectual environment is a necessary condition for being productive. This line of argument stresses that, independent of talent, authors require the right conditions to become productive: they need the confidence that feeds on success, access to research grants, freedom from teaching and administration, the esteem of their peers, access to specialist equipment, the stimulation of teams of fellow researchers, and a supportive and well managed research culture (David, 1994; Bozeman and Lee, 2003). These resources are all in scarce supply, and because publishing itself carries certain rewards (like credibility, standing), then there is a virtuous circle whereby these necessary resources flow disproportionately to those that publish more. But since competition for resources is so tough, only a few manage to break away from the rest of the pack.

Collaboration and Collaborative Coefficient

Multiple-authorship is widely considered as an indication of research collaboration. The underlying assumption is that the authors involved carried out the research leading to the paper in collaboration. Furthermore, author collaboration can be regarded as an indication of communication among scientists. The research process includes active communication among scientists through conversation, exchange of ideas through e-mail and letters, sharing equipment, writing articles, communicating research results or information, co-publishing, and joint-presentation of papers at conferences and seminars.

Collaboration is a significant factor in scholarly productivity. Just as the format of publication and the number of publications vary by discipline, so do collaborations and co-authorships (Bordons and Gomez, 2000; Meadows, 1998). Solo research is the norm in some disciplines, particularly in the humanities and in mathematics, while collaborative research is typical of most scientific disciplines.

Informetric studies of collaboration generally conclude that the amount of collaboration between scholars, as evidenced by the number of co-authors, is growing, and that the degree of collaboration continues to vary greatly by field (Arunachalam, 2000; Bordons and Gomez, 2000; Meadows, 1998; Pao, 1992; Russell, 2000). Borgman and Furner (2001) observe that the reasons for the growth in collaboration are many. One is the increasing specialization within disciplines such that multiple partners are often needed to tackle complex research

problems. Another is economics, given the need to amortize expensive laboratory equipment, computers, data, and other resources across multiple researchers and projects. Yet, another is sources of funding that encourage larger projects (Bordons and Gomez, 2000). Higher rates of collaboration are usually associated with higher productivity, although counts will vary based on the method of allocating authorship (e.g. one credit for each publication vs partial credit based on number of authors, etc.).

Yitzhaki (1990) observes that the phenomenon of multiple authorship has drawn a considerable amount of attention among students of the sociology of science. De Solla Price (1963) states that the phenomenon of collaborative authorship has been increasing steadily and ever more rapidly since the beginning of the century. He notes that more than 80% of all papers published in 1900 had a single author, and predicted that, at the then current rate, the single author paper would be extinct by 1980.

Hou, Kretschmer and Liu (2006) report that since the pioneering work of De Solla Price (1963) and Beaver and Rosen (1978, 1979a, 1979b), a large number of scholars have stressed different forms and roles of scientific collaboration in different scientific fields. Glanzel (2002) and Kretschmer (2004) observe that the investigations of these researches were at micro level (individuals), meso level (institutions), and macro level (countries).

Subramanyam (1983) reported that collaboration has been found to affect the visibility and productivity of scientists. He also argues that the degree of collaboration varies from one discipline to another. It is high in the scientific and technical fields, but low in the humanities. The degree of collaboration was also found to be discipline-based. Stankiewicz (1976) observed that the propensity to work in groups seems to reflect the intrinsic requirements of the research process for Swedish scientists. Stankiewicz's study indicated the frequency of group membership was highest in the rapidly developing fields such as physics, chemistry and molecular biology. In these fields, more than 90% of the scientists were group members. Group frequency was lower in fields such as biology, geography and engineering. Smart and Bayer (1986) and Bayer and Smart (1988) similarly proposed that collaboration is most common in "data disciplines" such as physics or chemistry. Collaboration is less widely practised in "word disciplines" such as sociology or political science, and is rare in fields such as philosophy or literature.

The results of collaboration can be measured in terms of co-authored works. A scientific document is co-authored if it has more than one author. It is institutionally co-authored if it has more than one author address. Other types of outputs as a result of collaboration are patents and personal contacts. Data on co-authored articles can be obtained from bibliographic database, especially the *Science Citation Index* and *Social Science Citation Index*. The types of analysis usually comprise aggregating co-authored works based on countries, cities, organizations, individuals or groups (Melin and Persson, 1996).

Lawani (1972) has introduced the term collaborative index to describe the average number of authors per paper for a given set of papers. He states that the greater the collaborative index of a set of papers, the higher the proportion of quality papers in that set. Therefore, the collaborative index can be used to measure the quality in the aggregate. Collaborative coefficient is a simple indicator that is used to measure the collaborative research patterns of a given institution (Subramanyam, 1983). It is the number of collaborative papers divided by total number of papers. This measure does not take into account the number of co-authors per paper.

Methodology

Collaboration on a research project involves immediate and detailed communication of information. Collaborative research typically results in the publication of works that list authors from the various institutions involved. The researcher used data on the institutional affiliations of authors of the articles published in the journals indexed in the Thomson Scientific databases to describe collaborative activity. The data of each document includes author names, title, abstract, date, document type, addresses, and cited references. Author names were standardised because some authors may report their names differently in different papers. Each author was identified by his or her surname and first initial only. The following parameters were used in this study: Lotka's Law of author productivity and Collaborative Coefficient.

Findings

Collaboration and Collaboration Coefficient

Figure 1 and Tables 1 and 2 present the year wise publication productivity, authorship pattern (single and multi-author), publication productivity, collaboration trend among researchers, and cumulative growth of publications. The degree of collaboration varied from year to year. There were altogether 669 researchers who published 220 publications retrieved from the Thomson Scientific Indexes. Four hundred and forty-three (66.22%) were foreign authors, while 226 (33.78%) were UNZA authors. Table 1 reveals that 15% of the articles were of single authorship; 9.09% of the articles involved 2 authors; 10.0% were written by 3 authors; 11.82% by 4 authors; and the remaining 54.09% were written by more than 4 authors.

It is obvious that between 2002 and 2004, there has been an almost consistent, and sometimes sharp, increase in the proportion of multiple authored papers, from about 50% to 91%. The proportion of single authorship oscillated from 9.38% to 18.91% during the period under study. These results demonstrate very clearly that there has been a definite trend towards multiple authorship in publishing at the University of Zambia between 2002 and 2004. This is reflected in the proportion of single-authored papers among the total amount of the papers published.

The study indicates that collaboration within UNZA, internal co-authorship, was very minimal. Out of the 220 publications, UNZA researchers only collaborated amongst themselves in 14 publications. Eleven of these publications involved two authors per publication, while three publications involved three authors per publication.

To measure the collaborative research pattern, a simple indicator called collaborative coefficient (number of collaborative papers divided by total number of papers), (Subramanyam, 1983) is used. This measure does not take into account the number of co-authors per paper. Using Subramanyam's (1983) measure, we may say that the "ratio of collaboration" rose from 50% in 2002 to 85% in 2007.

Table 1: Number of Authors per Publication at UNZA 2002-2007

Figures in brackets are column percentages.

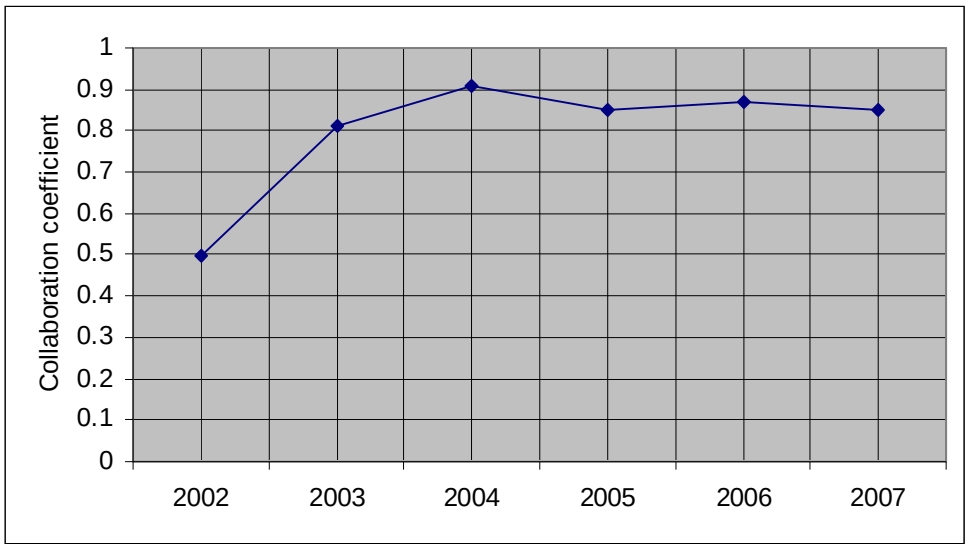


Fig. 1: Collaboration Coefficient of UNZA Researchers 2002-2007

There was a general increase from 2002 to 2004, and thereafter the collaboration coefficient tended to vary with a slight decline. The collaboration coefficient ranged from 0.50 and 0.91. The highest collaboration coefficient was 0.91 found in the year 2004. However, the general authorship trend is towards multi-authored papers. These findings are in conformity with earlier findings of several researchers such as De Solla Price (1963), Gupta and Karisiddappa (2000), and Kademani et al. (2005, 2006), who have conducted several studies in various disciplines, which show a trend towards multi-authorship papers.

Table 2 presents domain-wise authorship pattern and domain-wise collaboration coefficient. It is evident that the degree of collaboration varies from

Table 2: Number of Authors per Publication by Subject Category 2002-2007

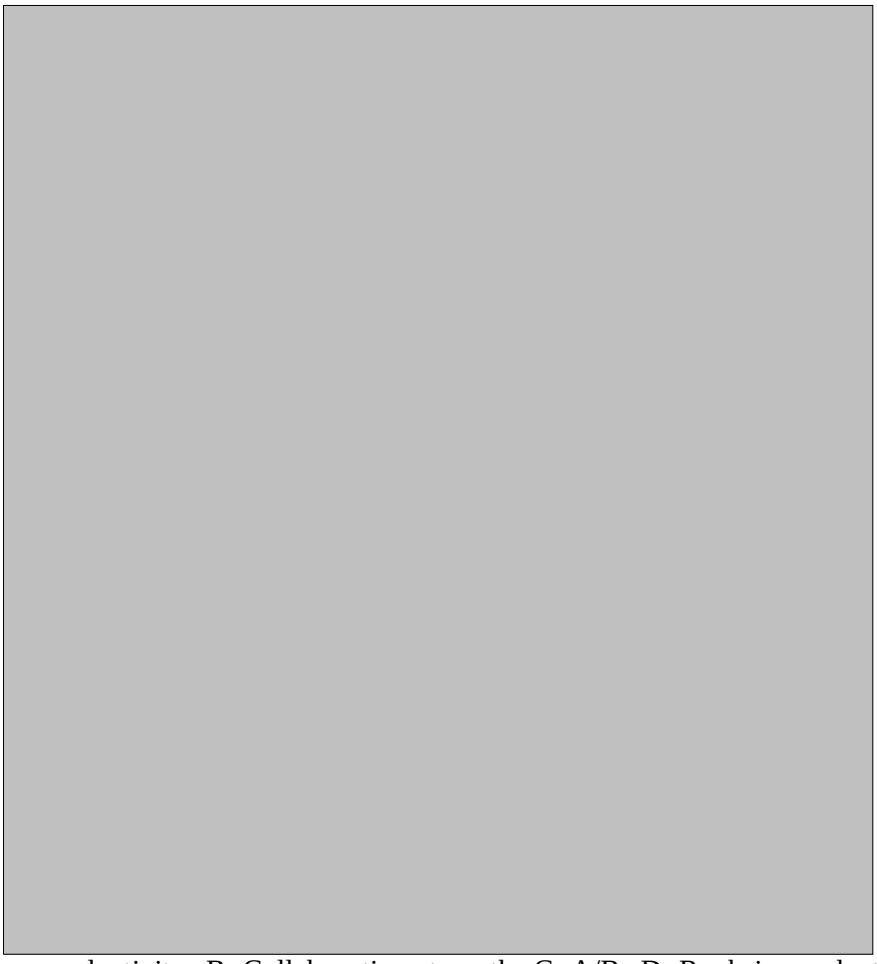
one discipline to another. However, the results above indicate that collaboration trend is more intensified in Medicine, Veterinary Medicine, Mines and Agricultural Sciences. It is generally low in Humanities and Social Sciences, Engineering,and Natural Sciences. The findings generally agree with Koganuramah, Angadi and Kademani's (2002) observation that collaboration coefficient is generally high in the intensely collaborative scientific and technical fields, but low in the humanities in which the lone scholar, working without the trapping of "big science", still produces much of the scholarly literature.

Relationship between Collaboration and Productivity

Further analyses were conducted to determine if there was any relationship between collaboration and author productivity. Table 3 summarises the data on the productivity of the most productive authors in relation to their collaborative strength. The collaborative strength of each author was calculated by counting the number of papers written with other authors in the data. The findings reveal that the most productive authors were also the most collaborative, i.e. their ranks tallied. All the three most productive authors, Moses Sinkala, I.K. Phiri, and C. Kankasa, were also the most collaborative authors, as they had all their publications jointly written with other authors.

Figure 2 shows that there is a positive relationship between author productivity and author collaboration. In order to assess the degree of association (correlation) between the variables, Pearson Product Moment Correlation Co-efficient was used. The resulting coefficient correlation of 0.97 (critical value is $p<0.01$) revealed a statistically

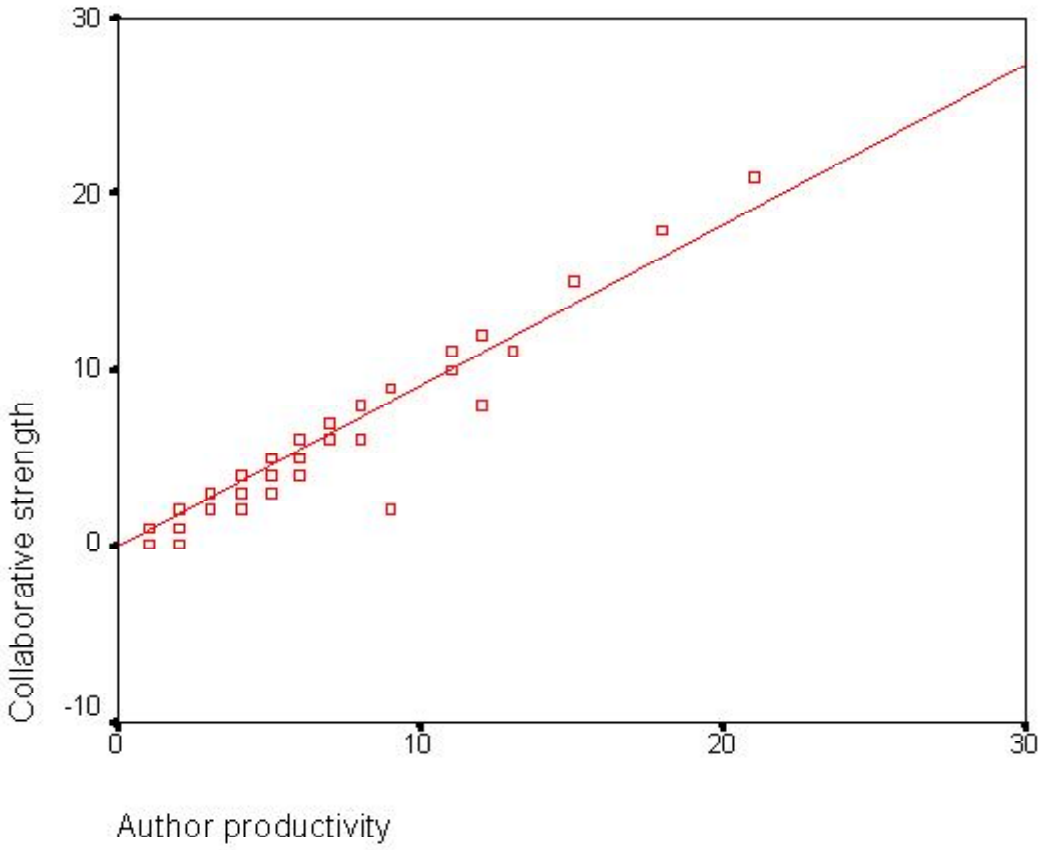
Table 3: Author Productivity versus Collaborative Strength



Key: A=Author productivity; B=Collaborative strength; C=A/B; D=Rank in productivity; E=Rank in collaboration

significant linear relationship between these two variables such that the more collaborative an author is, the more productive he or she is. These findings agree with the findings of Oyeniyi and Bozimo (2004), who observed that there was a positive correlation between author productivity and collaboration among authors of sorghum literature in Nigeria.

(4.56%). European countries comprised 34.33% of the collaborating partners. United States of America alone contributed 34.72% of the collaborating partners. There were 16 African countries that collaborated with UNZA researchers to publish articles. Two of these African countries (i.e. South Africa and Zimbabwe, ranking 5 and 6 respectively)



** Correlation is significant at the 0.01 level (2-tailed).

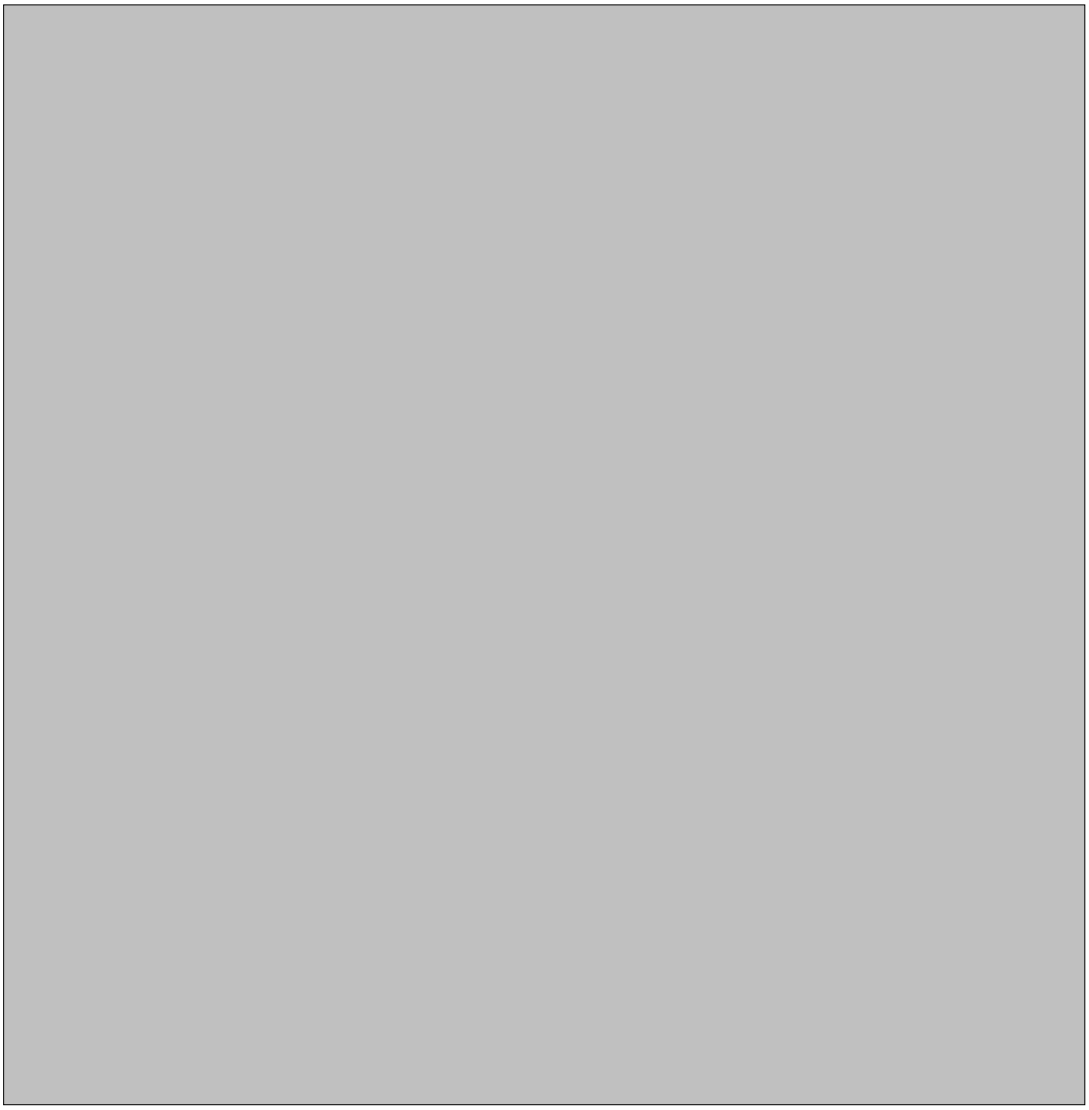
Fig. 2: Correlation between Collaboration and Productivity

Origin of Foreign Researchers Collaborating with UNZA Researchers

The origin of the foreign researchers collaborating with the University of Zambia in research and publishing is summarized in Table 4. Fifty-four countries collaborated with UNZA faculty in research. The top five most collaborating countries were USA (34.72%), England (11.11%), Japan (6.15%), Belgium (5.16%), and South Africa

are among the top ten most important collaborating partners. These findings suggest that there is a growing collaboration among UNZA scientists and the other scientists in the neighbouring countries. These findings show that journals represent a major outlet for disseminating collaborative research involving both UNZA researchers and researchers in developing and developed countries.

Table 4: Distribution of Collaborating Authors by Country



These findings seem to agree with Jacobs' (2001) observation that prestige, both personal and institutional, is considered an important aspect in research productivity. The above findings clearly indicate that scientists from developed countries collaborated with UNZA researchers more than scientists from other less developed countries. Although productivity is not directly proportional to the funding in all cases, there are reasons to believe that funding plays a major role in the overall productivity of the scientists, especially in the case of scientists in universities of developing countries like Zambia. An increased cooperation between national and international cooperation has opened doors to newer horizons for research and publication. Furthermore, collaboration can therefore be linked to universities with better and more expensive equipment. The findings of this study seem to agree with an unpublished study by Hirsch and Singleton, quoted by Yitzhaki and Ben-Tamar (1990), who observed that the prevalence of multiple authorship is closely related to the amount of financial support - government, foundation, or private - given to the research producing these papers. Furthermore, Subramanyam and Stephens (1982) argue that teams of researchers have a greater "pulling power" than individual ones in attracting external funding for research. Patel (1973) found a direct relationship between funded articles and multi-authorship. Heffner (1981) found that financial support for

research is associated with an increase in the total number of persons involved in the production of knowledge per journal article.

Validation of Lotka's Law

Lotka's law was fitted to the author productivity data, and the results were C = 0.4334 and á = 1.5921 (see details below). Lotka predicts that about 59% of the sources would produce one item.

C-Value: 0.4334

α : 1.5921

These results confirm that the patterns of collaboration between UNZA researchers and foreign researchers fit the Lotka's Law of distribution.

Implications of the Findings

The findings of this study have implications for library management. For instance, the increase in author-collaboration may lead to increased information needs. Consequently, libraries may have to purchase wide range of both local and foreign journals to meet the increasing needs of the authors. Local researchers have opportunities to publish in foreign journals, and this in turn may increase the number of journal titles required. Studying the relationships between the geographic distribution of authors and the journals they cite may help librarians to determine the geographic scope of influence of these journals. An increase in collaboration between Zambian and international researchers has opened doors to newer horizons for research and publication, and this has a corresponding effect on library and information resources and services. Finally, by collaborating with researchers in other institutions, local researchers have opportunities to have access to information resources in other institutions, and this in turn may reduce their dependence on local library resources.

Conclusion

This paper has attempted to analyze the University of Zambia academic faculty's research productivity during 2002-2007, downloaded from the Thomson databases (the Web of Knowledge). A noticeable increase in the number of multiple authored publications was observed, though at a somewhat slower pace than that predicted by De Solla Price (1963). Generally, single-authored publications seemed to fluctuate between 8 and 3 publications per year. Multiple-authored publications were significant in Veterinary Medicine (95.0%), Medicine (95.0%), and Mines (91.0%). The study has also established a positive relationship between author productivity and author collaboration. The more collaborative an author is, the more productive that author is. Finally, the study has observed a growing collaboration between University of Zambia researchers and other researchers in the Southern African universities.

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