

An Empirical Regularity in the Market for Risk and Insurance Research Output

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ABSTRACT

This study provides a means for evaluating the research productivity and output concentration of risk and insurance researchers by identifying an empirical regularity in the frequency distribution of article publications in six major risk and insurance journals. Our results reveal a strong bibliometric regularity, which provides a useful tool for assessing the likelihood of multiple publications in the insurance literature. Assuming that the publishing behavior of risk and insurance researchers is stable over time, we predict that less than four percent of all publishing risk and insurance researchers will publish six or more coauthored articles in the next fifteen years, and less than two percent will publish ten or more articles.

Introduction

Most of the research in economics and finance (see, e.g., Liebowitz and Palmer, 1984; Laband, 1985; Blair et al., 1986; Ederington, 1979) supports the use of article citation as the best quantitative measure of research productivity. Unfortunately, as noted by Cox and Gustavson (1990, p. 265), it is difficult for insurance researchers to evaluate peers or themselves by citation count, because only two insurance journals (*Journal of Risk and Insurance* and *Insurance: Mathematics and Economics*) are included in the *Social Science Citation Index*. This article provides an alternative basis for evaluating the relative performance of risk and insurance researchers by identifying an empirical regularity in the frequency distribution of risk and insurance researchers' article publications.

Lotka's Law

Lotka (1926) proposed an inverse square law relating authors of scientific articles to the number of articles written by each author. Using data from

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the decennial *Chemical Abstracts* and Auerbach's *Geschichtstafeln der Physik*, Lotka plots the number of authors against the number of contributions made by each author on a logarithmic scale. Lotka finds that the points are closely scattered around a straight line having a slope of approximately negative two. On the basis of this empirical observation, Lotka suggested the following equation to describe the pattern of research output among authors:

$$a_n = a_1/n^2, n = 1, 2, 3, \dots, \quad (1)$$

where a_n is the number of authors publishing n articles, and a_1 is the number of authors publishing one article. Subsequent studies (e.g., Mandelbrot, 1954; Bookstein, 1977; Simon, 1955; Price, 1976) have shown that the generalized version of Lotka's Law, $a_n = a_1/n^c$ ($c = \text{a constant}$), has not only an empirical validity but also theoretical robustness since it can be derived from different sets of assumptions (see Chung and Cox, 1990, pp. 302-303, for a detailed review of this literature).

Related Research

Several studies have descriptively analyzed risk and insurance research output. Outreville and Malouin (1985) identified leading risk and insurance journals based upon the qualitative perceptions of academic members of the American Risk and Insurance Association. Chandy and Thornton (1985) used the number of articles published in the *Journal of Risk and Insurance* and the *Journal of Insurance Issues and Practices* to report rankings of contributing institutions. Cox and Gustavson (1990) conducted a comprehensive study of academic research output in the risk and insurance discipline by documenting the productivity of individual authors, their employers, and the institutions granting authors' terminal degrees.

However, none of these studies has examined whether the pattern of productivity in the risk management and insurance literature conforms to a bibliometric regularity, such as Lotka's Law.¹ This study examines whether the bibliometric regularity depicted by Lotka's inverse square law and its generalized version exists in the insurance literature. Identifying such a bibliometric regularity will be particularly useful for risk and insurance researchers, because it will help assess the likelihood of multiple publications in the insurance literature. In addition, this study provides a historical

¹ Numerous authors have applied Lotka's Law to the literature of various disciplines. While in some studies Lotka's inverse square law holds (e.g., Schorr, 1975, in map librarianship and Chung and Cox, 1990, in finance), in others it does not. Voos (1974) finds that for the information science literature an exponent of 3.5 gives the best fit with empirical data. Schorr (1974) finds that Lotka's inverse square law does not apply to the literature of library science and proposes an inverse quadruple law whereby out of each 100 contributors of single articles, about six contribute two papers, about one contributes three papers, etc. Worthen (1978) reports that Lotka's Law does not fit the literature in medicine. Cox and Chung (1991) find that an exponent of 1.84 gives the best fit in the economics literature.

record of the market concentration in the risk and insurance research output, a factor that must be monitored as future editorial changes at the journals and reorganization of faculties take place.

Article Authorship

Our primary interest is to test for a bibliometric regularity in the *Journal of Risk and Insurance*, because it has been regarded as the most influential journal among those who publish primarily academic risk and insurance research (see Cox and Gustavson, 1990). In addition, we include five other risk and insurance journals. Authorship for all main articles, notes, and specialized articles is compiled for each of the six journals for the years 1976 through 1990, or for the journal's inaugural issue through 1990. Comments and author replies are excluded from the sample because they typically do not represent original research.

The data set includes the number of contributions in each journal, the number of authors who contributed to each journal, and the proportion of authors by the number of publications. For coauthored articles, we use both the "normal" count (each author of a coauthored article receives full credit) and the "adjusted" count (an author receives fractional credit, $1/n$, for a coauthored article with n authors).² The adjusted count may be a more relevant method of measuring research output in light of the finding by Sauer (1988, p. 855) that "an individual's [monetary] return from a coauthored article with n authors is approximately $1/n$ times that of a single-authored paper." In total, these six journals published 1,878 articles over the period of observation, and a total of 1,496 authors contributed to the journals (see Table 1).

The majority of authors (70.8 percent with the normal count and 74.1 percent with the adjusted count) publish only once, and less than four percent of authors contribute more than four adjusted articles. One-time authors are common in all six journals. For instance, 72 percent of all *Journal of Risk and Insurance* authors appear only once. Percentages of one-time authors range from 67 for the *Journal of Insurance Issues and Practices* to 80.4 for the *Geneva Papers*.

The noticeably large percentage of one-time authors for the *Geneva Papers* may reflect the more general nature of this journal with respect to its audience, geographic location, and review process. A higher proportion of European authors, practitioners, and nonspecialist economists have traditionally published in this journal. On the other hand, contributors to

² After calculating the coauthor adjusted count for each author, we treat authors with greater than or equal to $n - 0.5$ and less than $n + 0.5$ adjusted articles as having n adjusted articles. We aggregate the data for $n > 9$ for succinctness and also because the Chi-square test performed below requires that the expected (theoretical) number of observations in each category should be at least five. Detailed data for each journal for the case $n > 9$ are available from the authors upon request.

Table 1
Frequency Distribution of Authors by Number of Publications

	Number of Articles	Number of Authors	Frequency Distribution in Percent									
			1	2	3	4	5	6	7	8	9	>9
<i>Journal of Risk and Insurance</i>	616	583	72.0 ^a (78.8) ^b	16.0 (11.6)	4.5 (3.9)	1.9 (2.1)	2.2 (1.5)	0.9 (1.0)	1.2 (0.0)	0.0 (0.6)	0.7 (0.2)	0.7 (0.2)
<i>Geneva Papers</i>	319	286	80.4 (81.0)	12.2 (11.8)	4.5 (5.3)	1.0 (0.4)	1.0 (0.8)	0.0 (0.0)	0.3 (0.4)	0.0 (0.0)	0.0 (0.4)	0.3 (0.0)
<i>Journal of Insurance Issues and Practices</i>	222	209	67.0 (72.0)	16.7 (15.3)	5.7 (6.4)	3.8 (3.2)	3.8 (0.6)	1.0 (0.0)	0.0 (1.9)	0.5 (0.0)	0.5 (0.0)	1.0 (0.6)
<i>Journal of Insurance Regulation</i>	220	236	78.8 (85.5)	14.4 (9.4)	5.1 (4.5)	1.3 (0.0)	0.0 (0.0)	0.4 (0.5)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
<i>Insurance: Mathematics and Economics</i>	295	230	71.7 (74.5)	13.5 (13.3)	6.1 (3.2)	0.9 (2.7)	1.7 (1.6)	2.2 (1.6)	0.4 (1.1)	0.4 (0.0)	0.4 (0.5)	2.6 (1.6)
<i>Benefits Quarterly</i>	206	221	74.7 (81.8)	14.0 (11.4)	7.2 (4.5)	3.2 (1.7)	0.5 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.5 (0.6)
<i>All Journals</i>	1,878	1,496	70.8 (74.1)	13.7 (13.3)	5.6 (5.1)	3.1 (2.6)	1.7 (1.2)	1.3 (1.0)	0.7 (0.9)	0.5 (0.2)	0.5 (0.4)	2.1 (1.2)
<i>Lotka's Law^c</i>			60.8	15.2	6.8	3.8	2.4	1.7	1.2	0.9	0.8	6.4

^a This row gives the proportion of authors by the number of publications using normal count (i.e., each author of a coauthored article receives full count).

^b This row gives the proportion of authors by the number of publications using adjusted count (i.e., an author receives 1/n credit, for a coauthored article with n authors).

^c This row gives the proportion of authors predicted by Lotka's Law—the number of authors publishing n articles is $1/n^2$ of those publishing one article.

the *Journal of Risk and Insurance*, the *Journal of Insurance Issues and Practices*, and *Insurance: Mathematics and Economics* are more likely to have more than one article published than contributors to other journals. On average, about 30 percent of the authors have more than one publication in these journals; for all other journals, 22 percent of the contributors have multiple publications. This may be due to the fact that the *Journal of Risk and Insurance* and the *Journal of Insurance Issues and Practices* have existed for a longer period than other journals, and thus many authors have had the opportunity to publish more than once. Also, *Insurance: Mathematics and Economics* presumably has a narrower audience and body of contributors because of its limited focus (primarily on the interaction of insurance and mathematics, i.e., actuarial issues). Or, perhaps, this indicates a "superstars" phenomenon in these journals, whereby relatively few authors produce the majority of research output.³ Authors tend to publish in more than one journal. For individual journals, on average, 74 percent of the contributors were one-time authors. For all six journals combined, 71 percent of the contributors were one-time authors.

Lotka's Law: A Poor Predictor

According to Lotka's Law, the theoretical frequency distribution can be determined as follows. First note that

$$\Sigma a_i = a_1 \Sigma (1/i^2), \quad (2)$$

where a_i denotes the number of authors publishing i articles, and Σ denotes the summation over $i = 1$ to ∞ . Since it can be shown that $\Sigma (1/i^2)$ equals $\pi^2/6$,⁴ the proportion of all contributors publishing a single article should be:

$$a_1 / \{a_1 \Sigma (1/i^2)\} = 6/\pi^2 = 0.6079. \quad (3)$$

Likewise, the proportions of authors publishing $K = 1, 2, \dots, n$ articles should be

$$a_K / \{a_1 \Sigma (1/i^2)\} = (6/\pi^2)(1/K^2). \quad (4)$$

Our comparison of the theoretical and actual proportion of authors by the number of publications for all six journals shows that the actual proportion tends to be higher than the theoretical (Lotka's) proportion for $n = 1$ and lower for $n \geq 2$. This indicates that the value of the exponent (c) is larger than the value of 2 predicted by Lotka's Law (see the last two rows of Table 1). In order to test whether Lotka's Law applies to the observed data,

³The "superstar" phenomenon is widespread in many human activities (see, for example, Rosen, 1981, for theoretical discussions and Hamlen, 1991, for empirical evidence).

⁴The derivation is available from the authors upon request.

we performed the Chi-square goodness-of-fit test. The computed Chi-square statistic is 43.97 with the normal count and 72.71 with the adjusted count, whereas the critical value (at the one percent significance level) from the Chi-square table is 23.2. Thus, Lotka's Law does not describe the frequency distribution of publications in the risk and insurance literature as a whole. It tends to overestimate the proportion of authors with multiple publications and underestimate the proportion of one-time authors.

When applied to individual journals, Lotka's Law is also a poor predictor of the pattern of publication. The results of the Chi-square test for each journal are shown in Table 2. Of the six journals, only three (*Journal of Insurance Issues and Practices*, *Insurance: Mathematics and Economics*, and *Benefits Quarterly*) conform to Lotka's Law at the one percent significance level when we employ the normal count. When we use the adjusted count, only the *Journal of Insurance Issues and Practices* and *Insurance: Mathematics and Economics* conform to Lotka's Law. This result is consistent with the findings of Radhakrishnan and Kernizan (1979), Chung and Cox (1990), and Cox and Chung (1991), that Lotka's Law, when applied to individual journal data, does not adequately describe the empirical distribution in the computer science, finance, and economics literature, respectively.

Generalized Lotka's Law

Because other studies (e.g., Mandelbrot, 1954; Bookstein, 1977; Simon, 1955; Price, 1976) have shown that Lotka's Law can be generalized to the case of an arbitrary exponent, $a_n = a_1/n^c$, we tested the ability of the generalized version of Lotka's Law to adequately describe the empirical distribution of risk and insurance research output. For this, note first from $a_n = a_1/n^c$ that

$$a_n/a_1 = 1/n^c. \quad (5)$$

Taking the log of both sides of equation (5) we obtain

$$\log(a_n/a_1) = -c \log(n). \quad (6)$$

The generalized Lotka's Law can be tested by running the following regression with a constant term α using the empirical frequency distribution shown in Table 1.

$$\log(a_n/a_1) = \alpha + B \log(n) + e. \quad (7)$$

If the generalized Lotka's Law is valid, the intercept α in equation (7) will be zero. Thus a direct test of the generalized Lotka's Law can be performed by estimating equation (7) for each journal and for all journals combined and testing whether α is significantly different from zero.

The regression results are presented in Table 2. The table presents fitted values of α and B with their respective t-values and coefficients of

Table 2
Regularity in Research Output and Author Concentration Among Journals

	Chi-square Statistics ^a Lotka's Law ^b	Testing Generalized Lotka's Law ^c $\log(a_i/a_1) = \alpha + \beta \log(n) + e$			Applying Generalized Lotka's Law to Reveal Author Concentration $\log(a_i/a_1) = \beta \log(n) + e$		
		α (t-value)	β^d (t-value)	R ²	β (t-value)	R ²	Rank of Author Concentration
A. Results with Normal Count							
<i>Journal of Risk and Insurance</i>	25.00	-0.06 (-0.27)	-2.28 (-16.53*)	0.968	-2.31 (-41.22*)	0.994	3
<i>Geneva Papers</i>	29.82	-0.20 (-0.61)	-2.53 (-11.34*)	0.955	-2.65 (-25.78*)	0.990	5
<i>Journal of Insurance Issues and Practices</i>	3.67*	0.02 (0.06)	-2.14 (-14.38*)	0.955	-2.14 (-35.07*)	0.992	1
<i>Journal of Insurance Regulation</i>	17.65	0.18 (0.79)	-2.96 (-14.87*)	0.982	-2.83 (-28.41*)	0.994	6
<i>Insurance: Mathematics and Economics</i>	10.78*	-0.25 (-0.54)	-2.18 (-7.76*)	0.868	-2.32 (-20.56*)	0.977	4
<i>Benefits Quarterly</i>	11.25*	-0.25 (-0.43)	-2.16 (-5.26*)	0.842	-2.30 (-11.31*)	0.955	2
<i>All Journals</i>	43.97	-0.08 (-0.61)	-2.22 (-29.82*)	0.990	-2.27 (-75.29*)	0.998	
B. Results with Adjusted Count							
<i>Journal of Risk and Insurance</i>	42.42	-0.17 (-0.85)	-2.40 (-20.09*)	0.981	-2.50 (-47.40*)	0.996	4
<i>Geneva Papers</i>	31.61	-0.24 (-0.41)	-2.65 (-6.47*)	0.872	-2.80 (-15.31*)	0.971	5
<i>Journal of Insurance Issues and Practices</i>	3.42*	-0.19 (-0.39)	-2.09 (-6.46*)	0.872	-2.20 (-15.07*)	0.970	2
<i>Journal of Insurance Regulation</i>	26.56	-0.05 (-0.28)	-2.83 (-17.96*)	0.991	-2.86 (-37.25*)	0.997	6
<i>Insurance: Mathematics and Economics</i>	10.95*	-0.42 (-1.78)	-1.97 (-14.52*)	0.959	-2.19 (-33.47*)	0.991	1
<i>Benefits Quarterly</i>	17.81	-0.53 (-1.19)	-1.93 (-6.16*)	0.902	-2.22 (-11.42*)	0.963	3
<i>All Journals</i>	72.71	-0.02 (-0.11)	-2.44 (-19.29*)	0.976	-2.45 (-49.13*)	0.996	

^a Chi-square values with $\alpha = 0.01$ are 23.2 when the degree of freedom is ten and 15.1 when the degree of freedom is five.

^b Lotka's Law states that the number of authors publishing n articles is $1/n^2$ of those publishing one article.

^c The generalized Lotka's Law states that $a_n = a_1/n^c$, where a_n is the number of authors publishing n articles, a_1 is the number of authors publishing one article, and c is a constant.

^d β is the estimate of $-c$.

* Statistically significant at .01.

determination for each individual journal and for all journals combined. Panel A presents the results with the normal count and Panel B with the adjusted count. The explanatory power of equation (7) is very high for both individual journals and all six journals combined. For four out of six journals, the generalized Lotka's Law explains more than 95 percent of the empirical distribution of publication patterns when we employ the normal count. Similar results are obtained with the adjusted count. The model gives almost a perfect fit ($R^2 = 0.990$ with the normal count and 0.976 with the adjusted count) when it is applied to all journals combined. Furthermore, none of the estimated intercept terms is statistically different from zero at the one percent significance level. Therefore, the generalized version of Lotka's Law ($a_n = a_1/n^c$) provides an excellent description of the empirical distribution of the patterns of research output in the risk and insurance literature.

Since the intercept term in equation (7) is not significantly different from zero, better estimates of the exponent c are obtained by constraining the intercept α to equal zero and estimating the parameter β from the equation.

$$\log(a_n/a_1) = \beta \log(n) + e. \quad (8)$$

The results are presented in Table 2. For all six journals combined, the estimated exponent is 2.27 with the normal count and 2.45 with the adjusted count. Chung and Cox (1990) and Cox and Chung (1991) reported that the best empirical estimates of the exponent are 2.00 and 1.84, respectively, for the finance and economics literature. The lower author concentration in the risk and insurance literature than in finance and economics may be attributable to the relatively younger age of most risk and insurance journals. Also, risk and insurance journals publish works of many finance and economics researchers whose primary research areas are not risk and insurance.

For individual journals, the estimated exponents range from 2.14 for the *Journal of Insurance Issues and Practices* to 2.83 for the *Journal of Insurance Regulation* with the normal count. When we employ the adjusted count, the estimated exponents range from 2.19 for *Insurance: Mathematic and Economics* to 2.86 for the *Journal of Insurance Regulation*. The generalized Lotka's Law provides almost a perfect fit for the majority of journals—the R^2 values range from 0.955 to 0.994 with the normal count and from 0.963 to 0.997 with the adjusted count. Also, all six journals have exponents greater than two, indicating that the degree of author concentration for individual journals is somewhat less than that predicted by the original Lotka's Law. The ranking of author concentration based upon estimated exponents (the larger c indicates the lower rank) confirms our earlier observation that the journals with high concentrations among their contributors are the *Journal of Risk and Insurance*, the *Journal of Insurance Issues and Practices*, and *Insurance: Mathematics and Economics*.

Summary and Concluding Remarks

This study provides a historical record of market concentration and an alternative basis for evaluating the research productivity of risk and insurance researchers by identifying an empirical regularity in the frequency distribution of article publications in six journals publishing primarily risk and insurance research. Our empirical results suggest a strong bibliometric regularity for our full sample data: The number of authors publishing n coauthorship-adjusted articles is $1/n^{2.45}$ of those publishing one article. For the *Journal of Risk and Insurance*, the number of authors publishing n articles is $1/n^{2.50}$ of those publishing one article.

The identification of bibliometric regularities is useful in assessing the likelihood of multiple publications in the insurance literature. Assuming that the publishing behavior of risk and insurance researchers is stable over time, this study predicts that less than four percent of all publishing risk and insurance researchers will publish six or more coauthorship-adjusted articles in these journals over the next fifteen years and less than two percent will publish ten or more articles.

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