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Original Research

Application of Bradford's Law of Scattering to the Economics Literature During 2011-2020

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Abstract

The study has been conducted 330 journal articles contributions with a total of 9527 citations contributed by 763 authors published in volume 78, no. 309 to volume 87, no. 348 of the source Journal, Economica between 2011 to 2020. An analysis of the different forms of literature, subject-wise distribution, ranking of top 24 cited journals, and the application of Bradford's law in Economics literature has been made. Results indicate that major forms of literature are journal 6173 (64.795%), followed by Books 2097 (22.011%) and Working Papers 569 (5.972%). Economica has published an average of 33 articles per volume. The average number of citations appeared at 238.175 citations in each issue. 'American Economic Review', published from the USA, tops the list with a tally of 481 (7.792%) citations, 'Journal of Political Economy' with 399 (6.464%) citations, published from USA and followed by 'Economic Journal' with 335 (5.427%) citations from the UK as the third position. Economics literature is not fit well Bradford's Law. Leimkuhler model is also applied to verify Bradford's law of scattering in the field of Economics.

Keywords: Bradford's Law, Citation Analysis, Economica, Economics, Leimkuhler Model

Introduction

Citations in a written document are empirical and reflect the actual practices of the authors. Hence, analysis of a wide range of citations would reveal the reading usage pattern of literature of a community or a branch of it. Citation analysis gives quantitative support to the qualitative tests of time criterion that "the longer a specific finding lasts, the better it is proved to be" (Garfield, 1979, p. 241). Citation analysis is a mathematical analysis of references or citations appended at the end of each scientific communication as an essential part of it. Citation analysis identifies the core references in a subject by counting the citations. It is a technique that involves collecting, counting, and analyzing citations (Gawande & Choukhande, 2013).

In every subject, some journals are frequently referred to by the researchers because of the close relationship between the subject of the journals and the areas of research work. These highly cited journals are listed as core journals of the specific subject (Sudhier, 2010). The core journals are considered the 'central set of journals, which most clearly reflects the conceptual essence of the research reported in the discipline' (Summers, 1984). Information professionals are conducting citation or bibliometric analysis in the specific areas of their institutions to know the utility of information resources available in their libraries. Citation analysis has also been used to find out the literature used by scholars in different disciplines. This article attempts to study the citation pattern of Economica journal to determine the literature used by the Economists and verify whether Bradford's law of scattering is fit or not in the economic literature.

Literature Review

The first notable paper on the law was Vickery (1948) and Kendall (1960). The empirical law of concentration for articles in the scientific periodicals was proved by Bradford (1934). Bradford's law and related statistical patterns were drawn by Garfield (1979). The search for an exact formulation of Bradford's law was stated by Leimkuhler (1967). Brookes (1977) concentrated on Bradford's law and the science bibliography. An empirical examination of the law was done by Qiu (1990). Bradford's law was tested on the Keenan-Atherton data by Groos (1967). Brookes (1969) contributed his theory of Bradford's law in the commemorative issue of the Journal of Documentation. The theory of Bradford's law to calculate Leimkuhler's law was proposed by Egghe (1986). To identify a suitable model to explain the law of scattering, Ravichandra Rao (1998) fitted about 24 different models to the 12 different data sets. Wagner-Döbler (1996) has also made their comments on the law. In their articles, Nicolaisen and Hjørland (2007) presented the practical potentials of Bradford's law.

Some studies were carried out to verify the authenticity of Bradford's law. On the application side, Sengupta's (1973), Goffman and Morris' (1970) studies are important. The applicability of the two vital formulations (verbal and graphical) of Bradford's law of scattering was tested by Lal and Panda (1999). Gupta (1991) studied the applicability of Bradford's law to citation data in Ethiopian Medical Journal.

Other studies occurred to verify the Bradfrod's law in different subjects include Lawani (1973) in Agriculture, Nweke (1973) in Zoology, Tyagi (1986) in Physics, Asundi & Kabir (1996) in Horticulture and Tunga (2013) in also Horticulture, Bandyopadhyay (1999) in different disciplines, Shukla, Saksena & Riswadkar, (2001) in Biology, Gupta & Kumar (2001) in Theoretical Population Genetics, Sudhier (2007) in Physics literature, Kumar (2014) in Human-Computer Interaction Research literature, Paliwal (2016) in LIS literature, Hiremath, Gourikeremath, Hadagali & Kumbar (2016) Materials Science literature, Amsaveni (2016) in Neural Network literature, Nishavathi & Jeyshankar (2017) in Law literature collected from doctoral theses, Gourikeremath, Hiremath, Kumbar & Hadagali (2017) in Microbiology, Wagh, Gawande & Wadalkar (2018) in Home Science literature, Savanur & Hullolli (2018) in Solar Physics, Biradar & Tadsad (2015) in Economics literature and Savanur (2019) in also Economics literature, Biradar & Kumbar (2020) in Epidemiology literature, Khandar & Sonwane (2021) in Economics literature colleted from Ph D Theses.

The above previous studies confirm the application of Bradford's law of scattering in different disciplines. But few studies are conducted on the Economics literature. So this present study has attempted to fill up in literature evaluating Bradford's law of scattering in the discipline of economics.

Source Journal: ECONOMICA

Economica is an international journal devoted to research in all branches of economics.

Theoretical and empirical articles are published from all parts of the international research community. Economica is a leading economics journal, appearing high in the published citation rankings. In addition to the main papers which make up each issue, there is an extensive review section covering a wide range of recently published titles at all levels. From time to time, special issues on selected topics are published. They are available as either a single back issue or, if possible in the current year, are included in the annual subscription.

Economica (Print ISSN 0013-0427, Online ISSN 1468-0335) is published quarterly by Blackwell Publishers Ltd., 108 Cowly Road, Oxford OX4 IJF, UK, on behalf of The London School of Economics and Political Science and The Suntory and Toyota International Centers for Economics and Related Disciplines, and printed by J. W. Arrowsmith Ltd., Bristol.

The present study covers 9527 citations appended to 330 articles in volume 78, no. 309 to volume 87, no. 348 of the Economica during 2011 to 2020. For this purpose, the journal 'Economica' has been selected as the source journal. It is a quarterly publication containing theoretical and empirical articles published from all parts of the world by the contribution of the International Research Community. It was first published in 1921 as Economica, and from 1934 it was renamed as Economica, New Series.

Objectives of the Study

The objectives of the current study are to:

- identify the volume-wise distribution of articles and citations
- classify the form-wise distribution of cited literature
- determine the subject-wise distribution of cited journals
- find out the rank on top 24 used core journals on Economics
- (find out the rank on top 24 used core journals on Economics) please delete this objective
- find out the rank of the cited core journals on Economics
- verify the Bradeford's law of scattering is fit or not in the economic literature

Materials and Methods

The present study contains citation analysis of 9527 citations collected from 330 original articles of 10 volumes, including 40 issues published in the source journal, Economica, between 2011 and 2020. The citation base was obtained by collecting citations from each article of each issue of the source journal with adequate details. Citations are found at the end of each article under the heading "References". The reference was Xeroxed, and each citation was then transferred to 3"×5" slips. After that, each article is scanned, checked, examined, and tabulated for necessary data into separate sheets. MS-Excel spreadsheet and MS-word were used to store, tabulate, present and analyze the final statistical data collected to generate tables. Finally, all the collected data were recounted, compiled, tabulated, and analyzed for making observations. The parameters used for analysis were (i) form-wise distribution of citations, (ii) subject-wise distribution of cited journals, (iii) ranking of cited journals, (iv) the geographical distribution of citations. The journal titles were identified using Ulrich's International Periodicals Directory and World List of Scientific Periodicals.

Results and Discussion

The data have been analyzed in various tables such as volume-wise distribution of articles and citations, ranking of cited source literature, subject-wise distribution, and rank of top twenty-two cited journals on economics. A critical analysis applies Bradford's law and Leimkuhler model in Economics literature.

Volume-wise Distribution of Articles and Citations

Table 1 shows the year and volume-wise distribution of articles and citations from 2011 - 2020. It shows the trend regarding the productivity of the articles during the given period.

Table 1

Volume-wise Distribution of Articles and Citations

Year	Volume (No.)	Total articles	No. of citations	Average no. of citations per article	% of articles	% of citations
2011	78 (309-312)	36	1028	28.555	10.909	10.790
2012	79 (313-316)	33	897	27.181	10.000	9.415
2013	80 (317-320)	32	978	30.562	9.697	10.266
2014	81 (321-324)	30	898	29.933	9.090	9.426
2015	82 (325-328)	36	1126	31.278	10.909	11.820
2016	83 (329-332)	27	695	25.741	8.182	7.295
2017	84 (333-336)	35	984	28.114	10.606	10.328
2018	85 (337-340)	34	1098	32.294	10.303	11.525
2019	86 (341-344)	29	759	26.172	8.788	7.967
2020	87 (345-348)	38	1064	28.000	11.516	11.168
Total	10 Volumes	330	9527	28.791	100.000	100.000

Ten volumes (40 issues) of Economica contained 9527 citations in 330 articles, meaning that every issue published 8.25 (330 articles/40 issues) articles on average having 28.791 citations in each article during this study period. The average number of citations appeared 238.175 (9527 citations/40 issue) citations in each issue. The highest number of articles published during 2020 is 38 (11.516%), and 2015 has the highest number of citations, i.e., 1126 (11.820%).

Ranking of Cited Source Literature

Table 2 shows the analysis of citations based on bibliographic forms. The economics literature has been published in different forms of publications. The ranking of cited source materials shows that the highest citations are from the Journals.

Table 2
Ranking of Cited Source Literature

Rank	Form of Literature	No. of citation	Percentage of Citations	Cumulative Citation	Cumulative Percentage
1	Journals	6173	64.795	6173	64.795
2	Books	2097	22.011	8270	86.806
3	Working Papers	569	5.972	8839	92.778
4	Websites	217	2.278	9056	95.056
5	Discussion Papers	189	1.984	9245	97.040
6	Theses	84	0.882	9329	97.922
7	Conference Proceedings	52	0.546	9381	98.468
8	Reports	46	0.483	9427	98.951
9	Research Papers	31	0.325	9458	99.276
10	Unpublished Documents	26	0.273	9484	99.549
11	Govt. Publication	20	0.210	9504	99.759
12	Monographs	13	0.136	9517	99.895
13	Others	10	0.105	9527	100.000
	Total	9527	100.000	9527	100.000

Out of the total number of 9527 citations, 6173 (64.795%) citations are from Journals, followed by Books 2097(22.011%), Working Papers 569 (5.972%), and Websites 217 (2.278%). In other words, Journals and Books constitute 8270 (86.806%). The remaining 13.194% of citations are Discussion papers, Theses, Reports, Research papers, etc.

Subject wise Distribution of Cited Journals

Subject-wise distribution of cited journals in the field of Economics for the core journals is given in Table 3.

Table 3
Subject-Wise Distribution of Cited Journals

Sl. No.	Subject Headings	No. of Citations	Cumulative No. of citations	% of citations	% of cumulative No. of citations
1	American Economics	670	670	10.854	10.854
2	Econometrics	652	1322	10.562	21.416
3	Political Economics	563	1885	9.120	30.536
4	European Economics	528	2413	8.553	39.089
5	International Economics	432	2845	6.998	46.087
6	Monetary Economics	374	3219	6.059	52.146
7	Public Economics	362	3581	5.864	58.010
8	Labour Economics	338	3919	5.475	63.485
9	Statistics	314	4233	5.078	68.572
10	Industrial Relations	248	4481	4.017	72.589
11	Business Economics	216	4697	3.499	76.088
12	Human Resources	199	4896	3.224	79.312
13	Economic Research	171	5067	2.770	82.082
14	Economic History	154	5221	2.495	84.577

Sl. No.	Subject Headings	No. of Citations	Cumulative No. of citations	% of citations	% of cumulative No. of citations
15	Psychology	138	5359	2.235	86.812
16	Health Economics	122	5481	1.976	88.788
17	Medicine	91	5572	1.475	90.263
18	Social Economics	78	5650	1.264	91.527
19	Macroeconomics	72	5722	1.166	92.693
20	Financial Economics	65	5787	1.053	93.746
21	Organizational Behaviour	62	5849	1.004	94.750
22	Development Economics	48	5897	0.778	95.528
23	Foreign Affairs	36	5933	0.583	96.111
24	Agricultural Economics	31	5964	0.502	96.613
25	Microeconomics	30	5994	0.486	97.099
26	Law	25	6019	0.405	97.504
27	Population Economics	23	6042	0.373	97.877
28	Marketing	20	6062	0.324	98.201
29	Income & Wealth	18	6080	0.292	98.493
30	Management	15	6095	0.243	98.736
31	Others	78	6173	1.264	100.000
	Total	6173	6173	100.000	100.000

The analysis reveals that cited Journals are from different fields of Economics, and some are from outside the Economics discipline like Psychology, Medicine, Law, Management, Political Science, etc. The maximum number of cited Journals is from American Economics 670 (10.854%) citations, followed by Econometrics 652 (10.562%) citations, Political Economics 563 (9.120%) citations, and European Economics 528 (8.553%) citations in descending order.

The rank of the Cited Core Journals on Economics

A ranking list is essentially a practical tool designed to help library professionals and research scientists select the journals of maximum utility concerning their coverage of new and important literature in a particular subject area (Mete & Deshkukh, 1996). This type of analysis helps select periodicals and journals, assessing the importance of one or more journals and their utilization in terms of subject and time. Table 4 gives a ranked list of cited core journals with citations, countries of origin, and citation percentage.

Table 4
Rank List of the Cited Core Journals on Economics

Sl No	Rank	Name of cited journals	Year of origin	Country of origin	No of citation	Cumulative citations	% of citations	% of cumulative citations
1	1	American Economic Review	1911	USA	481	481	7.792	7.792
2	2	Journal of Political Economy	1892	USA	399	880	6.464	14.256
3	3	Economic Journal	1891	UK	335	1215	5.427	19.683
4	4	Econometrica	1933	UK	327	1542	5.297	24.980
5	4	Quarterly Journal of Economics	1886	USA	327	1869	5.297	30.277

Sl No	Rank	Name of cited journals	Year of origin	Country of origin	No of citation	Cumulative citations	% of citations	% of cumulative citations
6	5	Review of Economic Studies	1933	UK	292	2161	4.730	35.007
7	6	Economica	1934	UK	273	2434	4.422	39.429
8	7	European Economic Review	1969	UK	261	2695	4.228	43.657
9	8	Journal of Public Economics	1972	USA	248	2943	4.018	47.675
10	9	Journal of Monetary Economics	1973	Netherla	232	3175	3.758	51.433
11	10	Journal of Economic Literature	1969	USA	208	3383	3.370	54.803
12	10	Review of Economics & Statistics	1917	USA	208	3591	3.370	58.173
13	10	Journal of International Economics	1971	Netherla	208	3799	3.370	61.543
14	11	International Economic Review	1960	USA	207	4006	3.353	64.896
15	12	Journal of Labour Economics	1983	USA	160	4166	2.592	67.488
16	13	Journal of Econometrics	1973	Netherla	152	4318	2.462	69.950
17	14	Journal of Economic Theory	1969	USA	148	4466	2.398	72.348
18	14	Journal of Human Resources	1966	UK	145	4611	2.349	74.697
19	15	RAND Journal of Economics	1970	USA	129	4740	2.089	76.786
20	16	Oxford Eco. papers, New Series	1938	UK	118	4858	1.912	78.698
21	17	Journal of the American Statistical Association	1944	USA	118	4976	1.912	80.610
22	18	Journal of Business & Economics Statistics	1967	UK	106	5082	1.717	82.327
23	19	Journal of Applied Econometrics	1986	UK	95	5177	1.538	83.865
24	20	Journal of Economic Perspectives	1987	UK	81	5258	1.312	85.177
25		Others 306 cited journals (less than 81 citations) Total =330 Journals			915	6173	14.823	100.000
		TOTAL			6173			

This list consists of 24 top journals covering 5258 (85.177%) citations of the journal literature. The table indicates that ‘American Economic Review’, published from the USA, tops the list with 481 (7.792%) citations. ‘Journal of Political Economy’ with 399 (6.464%) citations, published from the USA, followed by ‘Economic Journal’ with 335 (5.427%) citations from the UK as the third position and ‘Econometrica’ with 327 (5.297%) citations from the UK as the fourth position.

Application of Bradford’s Law of Scattering

Bradford (1934) stated a scattering pattern for articles of scientific periodicals in Applied Geophysics and Lubrication, which was a landmark event in the field of bibliometrics. He plotted the partial sum of references against the natural logarithm of the partial sum of number of journals and noticed that the resulting graph was a straight line. Based on this observation, he established the following linear relation to describe a scattering phenomenon:

$F(x) = a + b \log x$, where F(x) is the cumulative number of references in the first X most productive journals, 'a' and 'b' are constants.

Bradford's Law of Scattering states that if a group of scientific journals is arranged in order of decreasing productivity of articles on a given subject, that is, the journal that yields the most relevant articles comes first and the most unproductive last, then the journals will be grouped into several zones each producing a similar number of relevant articles. However, the number of journals in each zone will be increasing rapidly. The relationship between the zones is 1: a: a^2 (Bradford, 1934). Where 1 represents the number of journals in the nucleus and "a" is a multiplier.

Table 6 shows several details of journals citations to test the verbal formulation of Bradford's Law. The number of cited journals has been arranged by decreasing number of citations, the rank, number of journals, number of citations, cumulative journals and citations, log of cumulative journals, and citations are given in the table.

Table 6
Distribution of Cited Journals in Decreasing order of Citations

Rank	NJ	CNJ	Log of NJ	NC	TNC	CNC	PCNJ	PCNC
1	1	1	0.000	481	481	481	0.303	7.792
2	1	2	0.301	399	399	880	0.606	14.256
3	1	3	0.477	335	335	1215	0.909	19.682
4	2	5	0.698	327	654	1869	1.516	30.277
5	1	6	0.788	292	292	2161	1.818	35.007
6	1	7	0.845	273	273	2434	2.121	39.430
7	1	8	0.903	261	261	2695	2.424	43.658
8	1	9	0.954	248	248	2943	2.727	47.675
9	1	10	1.000	232	232	3175	3.030	51.434
10	3	13	1.114	208	624	3799	3.940	61.542
11	1	14	1.146	207	207	4006	4.242	64.896
12	1	15	1.176	160	160	4166	4.545	67.487
13	1	16	1.204	152	152	4318	4.848	69.950
14	1	17	1.230	148	148	4466	5.152	72.347
15	1	18	1.255	145	145	4611	5.454	74.696
16	1	19	1.279	129	129	4740	5.757	76.786
17	2	21	1.322	95	190	4930	6.364	79.864
18	1	22	1.342	80	80	5010	6.667	81.160
19	1	23	1.361	69	69	5079	6.970	82.278
20	1	24	1.380	61	61	5140	7.273	83.266
21	1	25	1.398	54	54	5194	7.576	84.141
22	1	26	1.415	33	33	5227	7.879	84.675
23	1	27	1.431	31	31	5258	8.182	85.177
24	1	28	1.447	28	28	5286	8.485	85.631
25	3	31	1.491	27	81	5367	9.394	86.943
26	1	32	1.505	26	26	5393	9.697	87.364
27	1	33	1.518	24	24	5417	10.000	87.753
28	2	35	1.544	23	46	5463	10.606	88.498
29	1	36	1.556	22	22	5485	10.910	88.855

Rank	NJ	CNJ	Log of NJ	NC	TNC	CNC	PCNJ	PCNC
30	1	37	1.568	21	21	5506	11.212	89.195
31	1	38	1.579	19	19	5525	11.515	89.503
32	1	39	1.591	18	18	5543	11.818	89.794
33	2	41	1.613	17	34	5577	12.424	90.345
34	1	42	1.623	15	15	5592	12.727	90.588
35	1	43	1.633	14	14	5606	13.030	90.815
36	2	45	1.653	12	24	5630	13.636	91.204
37	1	46	1.662	11	11	5641	13.940	91.382
38	3	49	1.690	10	30	5671	14.848	91.868
39	1	50	1.698	9	9	5680	15.152	92.014
40	3	53	1.707	7	21	5701	15.454	92.354
41	6	59	1.756	6	36	5737	17.273	92.937
42	12	71	1.838	5	60	5797	20.909	93.909
43	19	90	1.944	4	76	5873	26.667	95.140
44	16	106	2.017	3	48	5921	31.515	95.918
45	28	134	2.120	2	56	5977	40.000	96.825
46	196	330	2.518	1	196	6173	100.000	100.000
Total	330	330	-	-	6173	-	-	-

NJ= No. of Journals, CNJ=Cumulative No. of Journals, Log of NJ= Log of No. of Journals, NC=No. of Citations, TNC=Total no. of Citations, CNC=Cumulative No. of Citations, PCNJ= Percentage of CNJ, PCNC=Percentage of CNC.

The distribution of journals, the corresponding number of citations in the three zones, and the multipliers' value of multipliers are shown in Table 7. In the present study, 6 journals covered 2161 citations (35.007%), the next 10 journals covered 2202 citations (35.671%), and the next 314 journals covered 1810 citations (29.321%). In other words, 6 journals covered 1/3 of the total citations, the next 10 journals accounted for another 1/3 citations, and the next 314 journals covered the remaining one-third citations. Thus the first zone contains 6 journals, followed by the second zone containing 10 journals, and the third zone having 314 journals.

Table 7
Scattering of Journals and Citations over Bradford's Zone

Zone	No. of Journals	No. of Citations	% of Journals	% of Citations	Multiplier
1	6	2161	1.818	35.008	-
2	10	2202	3.030	35.671	1.7 (10/6)
3	314	1810	95.152	29.321	31.4 (314/10)
Total	330	6173	100.000	100.00	33.1

According to Bradford, the zones, thus identified, will form an approximately geometric series in form 1: n: n^2. But it is found that the relationship of each zone in the present study is in the form:

6 : 10 : 314, i.e. 6 : 6×2 : 6×2^5, if 2 = n, then 6 : 6n : $6n^5$, or 1 : n : n^5

According to Bradford, the relationship between the zones is 1: n: n^5 while the relationship in each zone of the present study is 1: n : n5 which does not fit Bradford's distribution. Here, 6 denotes the number of periodicals in the nucleus and 16.5 multiplies. The mean value of the multiplier is 16.5 (33.1/2).

Hence, $6 : 6 \times (16.5) : 6 \times (16.5)^2 >> 1: n : n^2$ or, 6 : 99 : 1633.5 > > 1738.5

The percentage of error = (1738.5 – 330) × 100/330 = 1408.5×100/330 = 140850/330= 426.818

Since the error percentage is very high, the data will not fit well Bradford's Law. Therefore, the following method based on the Leimkuhler (1967) model is applied to verify Bradford's law of scattering.

Application of Leimkuhler Model

Leimkuhler (1967), Brrokes (1969), and Egghe (1986, 1990) have given mathematical expressions for Bradford's law. Egghe's method is based on the earlier formulation of Leimkuhler:

$R (r) = a \log_e (1 + br)$,

Where, R (r) = Cumulative number of articles contributed by journals of rank 1,2,3,….r

r_0 = Number of journals in Bradford's first group

y_0 = Number of articles in every Bradford group

k = Bradford's multiplier

y_m = Number of articles in the most productive journal (rank 1)

'a' and 'b' = constants that appear in Leimkuhler's formula

p = Number of Bradford group

A = Total number of articles and

T = Total number of journals

On explaining Leimkuhler's law, Egghe showed that $a = y_0/\log k$ and $b = (k-1)/r_0$

Egghe has introduced the mathematical formula for calculating the Bradford's multiplier(k) as $k = (e^g \times y_m)^{1/p}$, where 'g' is the Euler's number ($e^g = 1.781$), $y_0 = y^2_m \log k$ and $r_0 = T(k-1)/(k^p-1)$

From the present data it is found that $y_m = 437$, p = 3, A = 5328, T = 302, $y_0 = A/p = 6173/3 = 2057.67$,

$k = (e^g \times y_m)^{1/p} = (1.781 \times 481)^{1/3} = (856.661)^{1/3} = 9.497 = 9$ (approximate)

$r_0 = T(k-1)/(k^p-1) = 330(9-1)/(9^3-1) = (330\times8)/728 = 3.626 = 4$ (approximate)

$a = y_0/\log k = 2057.67 / \log 9 = 2057.67 / 0.954 = 2156.886 = 2157$ (approximate), and

$b = (k-1)/r_0 = (9.497-1)/3 = 8.497/3.626 = 2.343$

The required findings of the calculations are shown in Table 8. It shows that the number of journals in the nucleus is 4, and the mean value of the Bradford's multiplier is 8.528. Therefore, the revised Bradford's distribution is written as:

Table 8
Scattering of Journals and Citations over Bradford's Zone

Zone	No. of Journals	No. of Citations	% of Journals	% of Citations	Multiplier
1	4	1869	1.212	30.277	-
2	36	3674	10.909	59.517	9.000
3	290	630	87.879	10.206	8.055
Total	330	6173	100.000	100.000	17.055

Here, 4 denotes the number of periodicals in the nucleus and 8.528 multiplies. The mean value of the multiplier is 8.528 (17.055/2).

Hence, $4 : 4 \times (8.528) : 4 \times (8.528)^2 >> 1 : n : n^2$

or, $4 : 34.112 : 291.907 >> 330.029$

The percentage of error = (330.029 – 330) × 100/330 = 0.029×100/330 = 2.90/330= 0.0087

Since the percentage of error is negligible, the Bradford's law fits very well in this present data set in the field of Economics. However, as mentioned and proved by Bradford, three zones are not exactly the 1/3rd of total citations.

Major Findings

Based on the analysis carried out on the 330 articles with a total of 9527 citations contributed by 763 authors, the following major findings are drawn:

- Economica has published an average of 33 articles per volume. An average number of citations appeared 238.175 (9527 citations/40 issue) citations in each issue.
- On average, every issue published 8.25 (330 articles/40 issues) articles, having 28.870 citations in each article during this study period.
- The highest number of articles published during 2020 is 38 (11.516%). The highest number of citations appeared with 1126 (11.820%) citations in 2015 and least with 695 (7.295%) citations.
- Out of the total number of 9527 citations, 6173 (64.795%) citations are from Journals, followed by Books 2097 (22.011%), Working Papers with 569 (5.972%) citations, and websites with 217 (2.278%) citations.
- The maximum number of cited Journals is from American Economics 670 (10.854%) citations, followed by Econometrics 652 (10.562%) citations, Political Economics 563 (9.120%) citations, and European Economics 528 (8.553%) citations in descending order.
- 'American Economic Review', published from the USA, tops the list with 481 (7.792%) citations. 'Journal of Political Economy' with 399 (6.464%) citations, published from the USA, followed by 'Economic Journal' with 335 (5.427%) citations from the UK as the third position and 'Econometrica' with 327 (5.297%) citations from the UK as the fourth position.
- Bradford's law fits very well in this present data set in economics by applying the Leimkuhler model. However, as mentioned and proved by Bradford, three zones are not exactly the 1/3rd of total citations.

Conclusion

Quantitative analysis of the Economica journal has been accepted as a research area. Further, the results of such citation analysis provide a further understanding of the researchers in general and economic literature in particular. The present study aims to ascertain the volume-wise distribution of articles, sources of publications, subject distribution, and rank list of cited journals in the period 2011-2020. The applicability of Bradford's law has also been tested by applying the Leimkuhler model. It can be concluded that the journals highly cited are devoted to citation studies which show periodicals are, in fact, the best vehicle for communication of information. Mainly the authors refer to journals followed by books for the research purpose. The analysis also reveals a concentration of citations on very few key journals. A ranking list is a practical tool designed to help library professionals and research scientists select the journals of maximum utility concerning their coverage of new and important literature in a particular Economics subject. It can be concluded that the results of this type of study would be of great potential value in the management of library journal collection in the field of economics. Such analysis will be helpful to concerned users and contributors to recognize their information needs and requirements.

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