2018

GROWTH OF SCIENTIFIC PUBLICATIONS: AN ANALYSIS OF TOP TEN COUNTRIES

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ABSTRACT

The aim of this study is to examine the growth of scientific publications of top ten most productive countries during the period 1996 – 2015. The data was obtained from the SCOPUS database. Compound Annual Growth Rate and Relative Growth Index have been employed. The study reveals the growth pattern of top ten countries during the period 1996-2015 and shows the research concentrations in major disciplines. China registered highest growth during the period 1996-2015 and only India registered higher growth from 1996-2005 to 2006-2015. Further, there is a contrast in the pattern of growth rate of top ten countries in major disciplines.

Keywords: Bibliometrics; Growth Rate; Relative Growth Index; Scientific Publications; SCOPUS; Scimago

INTRODUCTION

The countries across the world show their power not only by their natural resources but also by the research output. The research output is used as the benchmark for measuring the quality and quantity of research carried out in a country or in a discipline.

A very few attempts have been made to examine the growth of publications in general or in a specific area or on a specific country using various databases such as SCOPUS, WoS, SCImago, etc. in the recent past.

Glanzel, Leta and Thijs (2006) examined the scientific output, ranking and world share of top 5 countries, top 10 countries with less than 2% in the world and Latin American countries.

Larsen and von Ins (2010) studied the growth rate of scientific publications from 1907 to 2007 using the data from a number of literature databases such as Chemical Abstracts, Compendex, Cambridge Scientific Abstracts, INSPEC, LNCS, Math Scinet, Physics Abstracts, PubMed, SCI / SSCI and SCOPUS.

Bornmann and Mutz (2015) examined the growth of science based on two different datasets (a) number of publications in WoS per publication year and (b) the number cited references in the publications of the source items per cited reference year.

A study by Elsevier (2013) reveals that India has achieved a substantial growth (14.4%) in research articles output during 2008-2012 based on the SCOPUS data which is higher than that of China, Brazil, Russia and the UK.

Pautasso (2012) studied the current rates of increase in scientific outputs using publication data from the Web of Science (1991-2010) for 18 biological sub-fields.

Jang and Kim (2014) studied the research output of twelve Asian countries in science and engineering for a five year period using the SCOPUS database.

Chinchilla-Rodríguez et al. (2015) analyzed the volume and visibility of Latin American scientific output in the area of public health based on the data obtained from SCImago Institutions Raking portal.

Cavacini (2016) analyzed the scientific productivity of Middle Eastern countries and compared with West Europe based on the SCImago Journal & Country Rank portal for the period 1996-2014.

To the best of my knowledge, no one detailed study has been undertaken to analyze the growth pattern of countries in major disciplines. Based on the data collected from the SCImago, the present study is designed to answer the following questions:

1. What are the top ten countries in terms of number of publications during 1996-2015?
2. What is the growth rate for the top ten countries?

3. What is the growth pattern of top ten countries in major disciplines?

DATA AND METHODOLOGY

The data for the present was retrieved from the SCOPUS database through 'SCImago Journal and Country Rank' (http://www.scimagojr.com/countryrank.php). All the document types are considered including both citable and non-citable indexed in journals covered by Scopus. Only number of publications by countries is taken for further analysis. In this study, top 10 countries in terms of number of publications during the period 1996-2015 are considered. Because of these countries were produced more than one *million* publications during this period. Further, the retrieved data has been analyzed with the following indicators:

Compound Annual Growth Rate

Compound Annual Growth Rate (CAGR) is used to measure to the growth over a period of time and it is obtained with the following formula:

$$CAGR = \left(\frac{Ending\ Value}{Beginning\ Value}\right)^{\frac{1}{n-1}} - 1$$

where, n = number of years

Relative Growth Index

Recently, a new indicator Relative Growth Index (RGI) was proposed by Elango et al. (2015) to compare the growth rate of a specific country with that of global. In this study, it is used to compare the growth rate of a country in a specific discipline with the country's growth rate in the study period. It is obtained by dividing the growth rate of a country in a specific discipline by corresponding growth rate of that country during the period 1996-2015:

$$RGI = \frac{Growth\ rate\ of\ a\ country\ in\ a\ discipline}{Growth\ rate\ of\ a\ country}.$$

RGI = 1 indicates that a country's growth rate in a discipline is equal to that country's overall growth rate; RGI > 1 (or <1) indicates that a country's growth rate in a specific discipline is greater (or lower) than that country's overall growth rate.

RESULTS

Growth of top ten countries

Growth rate (CAGR) of scientific production of top ten countries during the period 1996-2015 along with two ten year block periods is shown in table 1. Highest growth rate has been observed for China with 15.11% followed by India with 9.86% and least by Japan with 1.32% between 1996 and 2015. Growth rate has been decreased from first ten year block period (1996-2005) to second ten year block period (2006-2015) for all the top ten countries except India which growth rate has been increased by almost fifty percent. Negative growth rate has been observed for Japan from first block period to second block period.

Table 1 – Growth rate of top ten countries

Country	No. of Publications (1996-2015)	CAGR (1996-2015)	CAGR (1996-2005)	CAGR (2006-2015)
United States	9360233	2.84	4.29	1.16
China	4076414	15.11	21.15	9.16
United Kingdom	2624530	3.76	4.78	2.11
Germany	2365108	3.80	5.62	2.02
Japan	2212636	1.32	3.92	-1.34
France	1684479	3.39	4.61	1.84
Canada	1339471	4.13	5.68	2.3
Italy	1318466	4.97	5.58	3.93
India	1140717	9.86	7.69	11.39
Spain	1045796	6.55	8.18	4.53

Growth rate in major disciplines

Growth rate (CAGR) of scientific production of top ten countries in major disciplines during the period 1996-2015 is shown in table 2. It is observed from table 2 that there is not a common pattern of growth rate among the top ten countries in major disciplines. For example, United States and Spain achieved highest growth in social science where as China, United Kingdom, Germany and Japan in economics, France, Canada and Italy in business and India in dentistry. Similarly, United States achieved lowest growth in engineering where as China in physics and astronomy, United Kingdom, Japan and Italy in pharmacology,

Germany in materials science, France in arts and humanities, Canada and India in veterinary science, and Spain in business. With this raw data, one cannot understand the growth pattern of top ten countries. To support this, Relative Growth Index suggested by Elango et al. (2015) employed to compare the growth rate of top ten countries in a specific discipline with overall growth rate of that country during 1996-2015.

Table 2 – Growth rate in major disciplines (in %)

Subject	United States	China	United Kingdom	Germany	Japan	France	Canada	Italy	India	Spain
Agricultural and Biolog. Sciences	3.63	19.95	3.32	5.28	3.30	4.12	3.13	7.45	7.04	6.76
Arts and Humanities	4.92	19.60	7.26	8.52	3.40	-4.50	6.31	9.63	10.00	11.11
Bioch., Genetics and Mol. Biology	1.26	17.97	2.11	2.86	0.25	1.42	2.50	3.19	9.42	4.47
Business, Manag. and Accounting	3.98	14.65	7.14	8.99	9.43	12.72	7.25	14.04	12.58	1.20
Chemical Engineering	2.68	18.00	3.58	3.53	2.49	3.72	3.06	5.22	12.06	6.36
Chemistry	2.21	14.15	2.03	2.50	0.29	2.25	2.56	2.91	7.56	3.83
Computer Science	2.83	15.69	5.43	5.91	3.48	6.13	5.35	7.50	15.38	11.21
Decision Sciences	3.30	18.33	5.90	6.06	4.52	9.10	4.33	10.45	10.36	12.25
Dentistry	2.87	17.74	3.41	9.06	2.63	7.22	3.62	9.28	20.04	13.18
Earth and Planetary Sciences	2.54	14.42	3.93	4.53	3.44	4.10	2.84	6.17	5.37	6.74
Economics, Econometrics and Finance	4.89	27.29	8.25	11.16	9.52	11.49	5.37	13.22	18.62	12.10
Energy	3.58	16.75	5.48	6.55	3.63	6.79	5.84	8.98	10.66	11.37
Engineering	0.79	14.35	2.18	3.27	0.94	3.50	3.29	5.49	11.49	8.41
Environmental Science	3.54	18.83	4.23	5.83	3.87	5.66	4.67	8.24	10.39	8.53
Health Professions	3.17	20.63	3.20	4.82	3.70	5.32	5.60	5.67	12.26	12.40
Immunology and Microbiology	1.90	20.51	1.74	2.89	-0.13	1.38	2.63	4.06	7.81	4.00
Materials Science	1.35	13.00	1.56	1.86	0.02	2.20	2.99	3.71	7.88	4.98
Mathematics	2.15	13.06	5.41	3.56	2.62	4.77	3.54	5.40	9.69	7.42
Medicine	2.92	19.24	3.18	3.48	1.00	2.46	4.77	3.69	10.18	5.62
Neuroscience	2.11	21.86	3.12	3.76	-0.41	2.28	3.82	4.12	10.99	5.77
Nursing	5.09	20.47	6.24	4.86	5.29	9.72	6.87	5.35	9.21	13.34
Pharmacol., Toxicol. and Pharmaceut.	1.64	14.27	0.93	2.04	-1.94	0.18	1.69	2.47	10.08	2.02
Physics and Astronomy	1.11	11.58	2.58	1.93	0.09	2.11	2.84	2.90	6.90	4.61
Psychology	3.43	23.88	5.14	7.80	3.54	7.75	4.59	9.49	12.01	11.43
Social Sciences	6.04	19.37	7.51	10.43	7.99	10.48	7.61	12.06	12.64	16.55
Veterinary	1.51	21.56	2.48	2.45	-0.33	2.58	1.33	9.66	3.26	4.10
Multidisciplinary	3.34	13.33	6.64	6.62	8.62	6.13	6.42	9.73	9.25	12.05

Relative Growth in major disciplines

Accordingly, Relative Growth Index (RGI) is calculated for top ten countries in major disciplines during the period 1996-2015 and shown in the table 3.

All the 10 countries achieved higher growth than its overall growth in the fields of computer science, decision science, economics, energy, environmental science, psychology and social science. On the other hand, all the 10 countries achieved lower growth than its overall growth in the fields of chemistry, materials science, pharmacology and physics. In some disciplines, only few countries achieved higher growth than its overall growth e.g. China in biology and immunology, China and India in neuroscience. On the other hand, few countries achieved lower growth than its overall growth e.g. United Kingdom, Canada and India in agriculture, United Kingdom and Canada in dentistry, United Kingdom in health professionals, India in nursing, China and India in multidisciplinary.

Table 3 – Relative Growth Index of top ten countries in major disciplines

Discipline	United States	China	United Kingdom	Germany	Japan	France	Canada	Italy	India	Spain
Agricultural and Biolog. Sciences	1.28	1.32	0.88	1.39	2.51	1.22	0.76	1.50	0.71	1.03
Arts and Humanities	1.73	1.30	1.93	2.24	2.58	-1.33	1.53	1.94	1.01	1.70
Bioch., Genetics and Mol. Biology	0.44	1.19	0.56	0.75	0.19	0.42	0.60	0.64	0.96	0.68
Business, Manag. and Accounting	1.40	0.97	1.90	2.36	7.15	3.75	1.76	2.82	1.28	0.18
Chemical Engineering	0.94	1.19	0.95	0.93	1.89	1.09	0.74	1.05	1.22	0.97
Chemistry	0.78	0.94	0.54	0.66	0.22	0.66	0.62	0.59	0.77	0.58
Computer Science	1.00	1.04	1.44	1.55	2.64	1.81	1.30	1.51	1.56	1.71
Decision Sciences	1.16	1.21	1.57	1.59	3.43	2.68	1.05	2.10	1.05	1.87
Dentistry	1.01	1.17	0.91	2.38	2.00	2.13	0.88	1.87	2.03	2.01
Earth and Planetary Sciences	0.89	0.95	1.04	1.19	2.61	1.21	0.69	1.24	0.54	1.03
Economics, Econometrics and Finance	1.72	1.81	2.19	2.93	7.22	3.39	1.30	2.66	1.89	1.85
Energy	1.26	1.11	1.46	1.72	2.75	2.00	1.41	1.81	1.08	1.74
Engineering	0.28	0.95	0.58	0.86	0.71	1.03	0.80	1.10	1.17	1.28
Environmental Science	1.24	1.25	1.12	1.53	2.94	1.67	1.13	1.66	1.05	1.30
Health Professions	1.12	1.37	0.85	1.27	2.81	1.57	1.36	1.14	1.24	1.89
Immunology and Microbiology	0.67	1.36	0.46	0.76	-0.10	0.41	0.64	0.82	0.79	0.61

Materials Science	0.48	0.86	0.42	0.49	0.02	0.65	0.72	0.75	0.80	0.76
Mathematics	0.76	0.86	1.44	0.94	1.99	1.41	0.86	1.09	0.98	1.13
Medicine	1.03	1.27	0.84	0.91	0.76	0.73	1.15	0.74	1.03	0.86
Neuroscience	0.74	1.45	0.83	0.99	-0.31	0.67	0.93	0.83	1.11	0.88
Nursing	1.79	1.35	1.66	1.28	4.01	2.86	1.66	1.08	0.93	2.04
Pharmacol., Toxicol. and Pharmaceut.	0.58	0.94	0.25	0.54	-1.47	0.05	0.41	0.50	1.02	0.31
Physics and Astronomy	0.39	0.77	0.68	0.51	0.07	0.62	0.69	0.58	0.70	0.70
Psychology	1.21	1.58	1.37	2.05	2.68	2.28	1.11	1.91	1.22	1.74
Social Sciences	2.12	1.28	2.00	2.74	6.07	3.09	1.84	2.43	1.28	2.53
Veterinary	0.53	1.43	0.66	0.64	-0.25	0.76	0.32	1.94	0.33	0.63
Multidisciplinary	1.17	0.88	1.76	1.74	6.54	1.81	1.55	1.96	0.94	1.84

Further, it is demonstrated with a specific discipline (Agricultural & Biological Sciences) and a top country (United States) in the Figures 1 & 2. It is observed from Fig. 1 that the growth rate in Agricultural & Biological Sciences is lower than the overall growth rate for three countries United Kingdom, Canada and India. Similarly, Fig.2 shows that the RGI of United States in various disciplines.

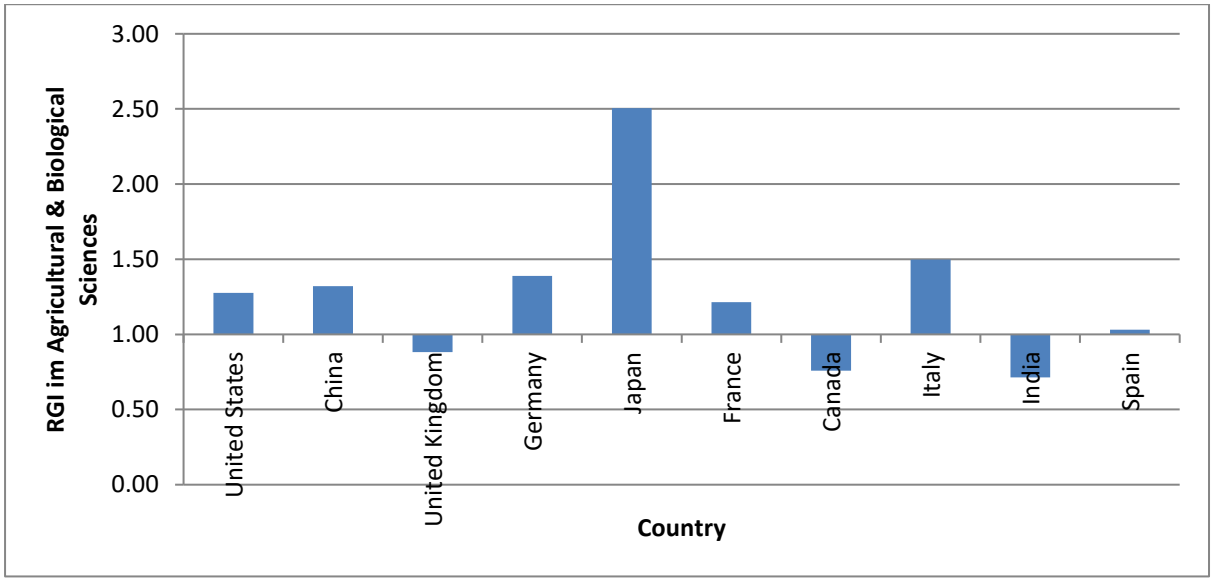

Figure 1 – RGI for top countries in Agricultural & Biological Sciences

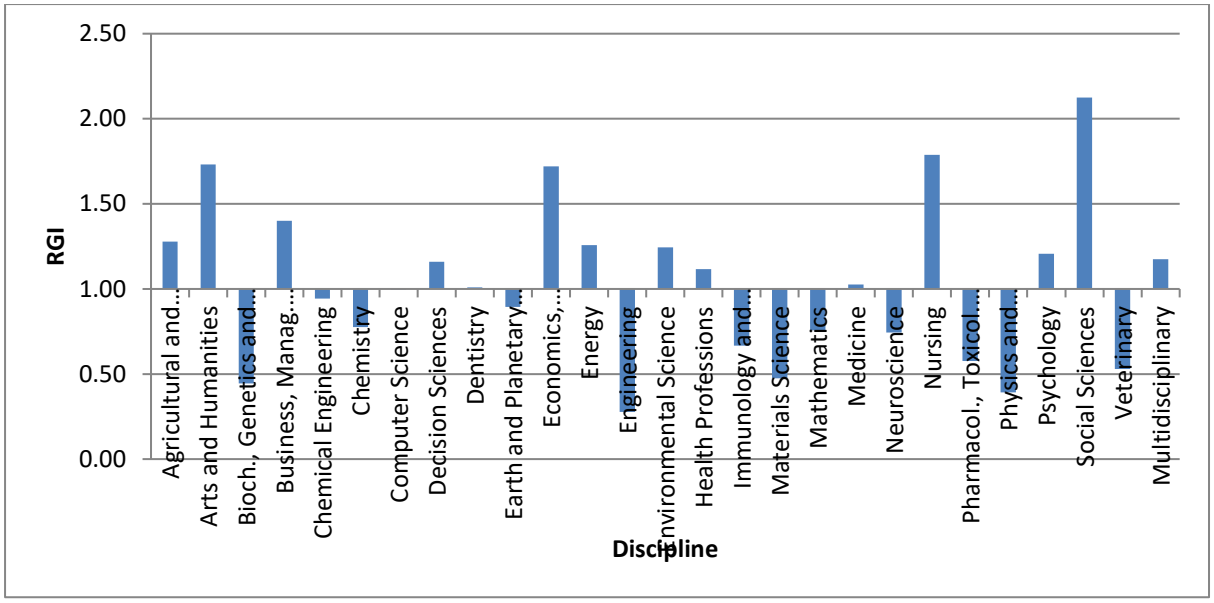

Figure 2 – RGI for United States in major disciplines

CONCLUSION

In this study, top ten countries during the period 1996-2015 in terms of number of publications have been identified based on the data retrieved from SCImago. Further, RGI has been extended to disciplines and demonstrated. From the observations, highest growth rate has been observed for China during the study period and only India achieved higher growth in the second ten year block period than first ten year block period. In general, all the top ten countries concentrate in the disciplines *computer science, decision science, economics, energy, environmental science, psychology and social science*. With the relative indicator Relative Growth Index (RGI), one can explore the assessing units' (country or institution) concentration in which disciplines. It is believed that the indicator (RGI) demonstrated in this study could be useful to the general scientometrics and bibliometrics community for research assessment.

REFERENCES

Bornmann, L. and Mutz, R. (2015). Growth rates of modern science: a bibliometric analysis based on the number of publications and cited references. *Journal of the Association for Information Science and Technology*, 66 (11), 2215-2222.

Cavacini, A. (2016). Research trends in Middle Eastern scientific production. *Scientometrics*, 109 (1), 423-432.

Chinchilla-Rodríguez, Z., et al. (2015). Latin American scientific output in Public Health: combined analysis using bibliometric, socioeconomic and health indicators. *Scientometrics*, *102*(1), 609-628.

Elango, B., Rajendran, P. and Bornmann, L. (2015). A scientometric analysis of international collaboration and growth of literature at the macro level. *Malaysian Journal of Library and Information Science*, 20 (2), 41-50.

Glanzel, W., Leta, W. and Thijs, J. (2006). Science in Brazil. Part 1: a macro-level comparative study. *Scientometrics*, 67 (1), 67-86.

Jang, H. and Kim, H. (2014). Research output of science, technology and bioscience publications in Asia. *Science Editing*, 1 (2), 62-70.

Larsen, P.O. and von Ins, M. (2010). The rate of growth in scientific publication and the decline in coverage provided by Science Citation Index. *Scientometrics*, 84 (3), 575-603.

Pautasso, A. (2012). Publication growth in biological sub-fields: patterns, predictability and sustainability. *Sustainability*, 4, 3234-3247.

Rousseau, R., & Yang, L. (2012). Reflections on the activity index and related indicators. *Journal of Informetrics*, *6*(3), 413-421.

SCImago. (2017). SJR – SCImago Journal & Country Rank. Retrived March 2017, from http://scimagojr.com

Schubert, A., Glänzel, W., & Braun, T. (1989). Scientometric datafiles. A comprehensive set of indicators on 2649 journals and 96 countries in all major science fields and subfields 1981–1985. *Scientometrics*, *16*(1-6), 3-478.

Jazayeri, S. B., Alavi, A., & Rahimi-Movaghar, V. (2012). Situation of medical sciences in 50 top countries from 1996 to 2010-based on quality and quantity of publications. *Acta Medica Iranica*, *50*(4), 273.