

# Science Funding Research Output in BRIC Countries: A Scientometric Analysis

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## **Abstract**

*This paper has examined the funding supported by funding agencies Science Citation Index (SCI) papers published in BRIC countries. The data was downloaded from web of science database which was maintained by Thomson Reuters. The study found out that China had published the maximum number funding supported SCI papers, contributing to 652,709 records. In the classification of funding sources, Russia and China fall in Single funding agency predominated type whereas Brazil and India fall in Funding sources diversified type. In the extent of International collaboration, Brazil, India and China had maximum number of collaborations with USA while Russia had collaborated often with Germany. Chemistry is the core research area for Brazil, India and China whereas Physics is the major research area for Russia. Further, the top three funding agencies and the contribution of core journals were also discussed in this paper.*

**Keywords:** Science Funding, BRIC Countries, Scientometrics, Web of Science, SCI

## **1. Introduction**

Research and development (R&D) is of utmost necessity to develop a country's production potential and also its science and technology sector. It helps a nation to progress and bring about innovation in all sectors. Most research funding comes from two major sources, corporations and government. Some small amounts of scientific research are carried out by charitable foundations, especially in relation to developing cures for diseases such as cancer, malaria and AIDS. According to OECD (Organization for Economic Co-operation and Development), around two-thirds of research and development in scientific and technical fields is carried out by industries, and 20% and 10% respectively by universities and government. With the rapid growth of R & D investment, funding has been playing a very important role in scientific research and paper publishing.

The acronym for BRIC refers to Brazil, Russia, China and India. It was coined by Jim O'Neill in 2001 in Goldman Sachs paper entitled "Building Better Global Economic BRICs", which speculated that by 2050 these four economies would be wealthier than most of the current major economic powers. Quantitative studies measuring and analyzing scientific research is commonly known as scientometrics. It gives emphasis on investigations in which the development and mechanism of science are studied by statistical mathematical methods. In this study we analyze the funding supported SCI papers in BRIC countries in order to carry out a quantitative assessment on the influence of funding agencies on research output.

## **2. Review Of Literature**

V. A. Markusova et.al(2012) analyzed the impact of competitive funding on research output in Russia found out that Russian publications of research supported by foreign funding agencies have more visibility and appear in journals with an average mean



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impact factor 1.9 times higher than average Russian publications in Web of Science.

X.Wang et.al (2011) analyzed the science funding research output in ten countries and found out that China, Germany and Spain are single funding agency dominated countries, while USA, Japan, Canada and Australia are double funding agencies dominated countries, and the source of funding in UK, France and Italy is diversified.

Leydesdorff and Wagner (2009) examined the macro level indicators of the relation between research funding and research output and concluded that the price per paper cannot be estimated.

L.Butler(2003), in explaining Australias share of increased ISI publications found out that the driving force behind the Australian trend appears to lie with the increased culture of evaluation faced by the sector on his study.

**3. Objectives**

- ▶▶ To identify the SCI papers and funding-supported SCI papers in BRIC countries.
- ▶▶ To analyze the top three funding agencies in BRIC countries.
- ▶▶ To find out the types of funding sources in BRIC countries.
- ▶▶ To determine the extent of international collaboration

- ▶▶ To examine the core research areas in BRIC countries.
- ▶▶ To analyze the contribution of top five journals in BRIC countries.

**4. Methodology**

The data for the study were retrieved from web of science database which is a scientific and indexing service maintained by Thomson Reuters. The funding supported SCI papers published in BRIC countries were analyzed in this paper. The following search strategy has been used to extract data for the BRIC countries.

ADDRESS-ABS-KEY ("India") OR ADDRESS-ABS-KEY ("Brazil") OR ADDRESS-ABS-KEY ("Russia") OR ADDRESS-ABS-KEY ("China") AND PUBYEAR (All years) and further by limiting the funding agencies, the data were downloaded.

The bibliographic details such as Journals, research areas, collaboration etc were downloaded as CSV format and further analyzed using Microsoft Excel.

**5. Analysis**

A total of 902,321 supported by funding agencies SCI were published by the BRIC countries. The research output was analyzed using various scientometric indicators.

**5.1. SCI Papers and Funding –Supported Papers In BRIC Countries**

**Table 1: The number of SCI papers and funding-supported papers in BRIC countries**

Country	No.of Sci Papers	Rank	No of Funding Supported Sci Papers	Rank	Propotion(%)	Rank
BRAZIL	522,794	4	92,261	2	17.68	2
RUSSIA	628,330	3	80,561	3	12.82	3
INDIA	935,761	2	76,790	4	8.20	4
CHINA	1,893,270	1	652,709	1	34.47	1

Table 1 displays the number of SCI papers and funding-supported papers in BRIC countries. In the number of SCI papers, it is clearly seen from the table that China has published a maximum of 1,893,270 SCI papers and ranked first, followed by India with 935,761 SCI papers. Russia and Brazil are ranked third and fourth with 628,330 and 522,794 SCI papers respectively.

In analyzing the funding-supported SCI papers, China ranked first with 652,709 papers, followed by Brazil, Russia and India with 92,261, 80,561 and 76,790 papers respectively. It is also noted that Brazil with the least number of SCI papers among the BRIC countries, has published more number of funding supported SCI papers.

Among the BRIC countries, the proportion of funding papers in China is as high as 34.47% which means that 34% of China's SCI papers are supported by funding agencies.

## 5.2. Funding Agencies

Table 2: Top Three Funding agencies in BRIC countries

Countries	Funding Agencies	No.of.papers	Propotion (%)
BRAZIL	CNPQ	35863	38.87
	CAPES	19251	20.86
	FAPESP	16395	17.77
RUSSIA	RFBR	60312	74.86
	Ministry of Education and The Science of Russian Federation Presidium of	9086	11.27
	The Russian Academy of Sciences	5942	7.37
INDIA	CSIR	32676	42.55
	DST	27730	36.11
	UGC	18504	24.09
CHINA	National Natural Science Foundation of China	522,570	80.06
	National Basic Research Program of China	71,646	10.97
	Fundamental Research Funds For The Central Universities	44,006	6.74

Table 2 presents the top three funding agencies in BRIC countries. In Brazil the top three funding agencies are: CNPQ (The Brazilian National council for scientific and Technological Development), CAPES and FAPESP. CNPQ contribute the maximum number of publications with 35863 papers contributing to 38.87% of funding-supported SCI papers. In Russia the top three funding agencies are: RFBR (Russian Foundation for Basic Research), Ministry of Education and the Science of Russian Federation and Presidium of the Russian Academy of Sciences. The maximum number of publications comes from the agency "RFBR" with 60312 papers, contributing to 74.86% of funding-supported SCI papers. In India, the top three funding agencies are: CSIR (Council of Scientific and Industrial Resource), DST (Department of Science and Technology) and UGC (University Grants Commission). CSIR contributes the maximum number of publications with 32676 records contributing to 42.55% of funding-supported SCI papers. In China, the top three funding agencies are: National Natural Science Foundation of China, National Basic Research Program of China and Fundamental Research Funds for the Central Universities. The maximum number of publications comes from the agency "National Natural Science Foundation of China" with 522,570 records contributing to 80.06% of funding-supported SCI papers.

## 5.3. Types of Funding Sources

Table 3: Three types of Funding Sources

Condition	Type	Countries Satisfied
$R_{1,2} > 2, P_1 > 30\%$	Single Funding Agency Predominated	Russia, China
$R_{1,2} < 2, R_{2,3} > 2, P_2 > 10\%$	DOUBLE Funding Agency Predominated	-
$R_{1,2} < 2, R_{2,3} < 2$	Funding Source Diversified	India, Brazil

In order to quantify the difference of funding sources in BRIC countries, we calculate the ratio of proportions of different funding agencies using the following equation.

$$R_{1,2} = \frac{P_1}{P_2}, R_{2,3} = \frac{P_2}{P_3}$$

Where

- ▶  $P_1, P_2$  and  $P_3$  denote the proportion of papers supported by the 1<sup>st</sup>, 2<sup>nd</sup> and 3<sup>rd</sup> funding agency in one country.
- ▶  $R_{1,2}$  is the ratio of  $P_1$  to  $P_2$ .
- ▶  $R_{2,3}$  is the ratio of  $P_2$  to  $P_3$ .

**5.3.1. Single Funding Agency Predominated**

At First, the value of  $R_{1,2}$  is calculated. The threshold is set as 2 which means if  $R_{1,2}$  is greater than 2 the number of papers supported by the first funding agency is more than twice than the second funding agency and the second condition is  $P_1$  must be greater

than 30%. If both the conditions are satisfied, it is considered that 1<sup>st</sup> funding agency dominates the funding sources in the country which is called Single funding agency predominated type. Among the BRIC countries, Russia and China fall into this category.

**5.3.2. Double Funding Agency Predominated**

In order to find Double funding agency predominated type the value of  $R_{2,3}$  is calculated. The same threshold of 2 is set which means if  $R_{2,3}$  is greater than 2,  $R_{1,2}$  is less than two and  $P_2$  greater than 10%. If these three conditions are satisfied, it is considered as Double funding agency predominated type. Among the BRIC countries, No country fall into this type.

**5.3.3. Funding Source Diversified**

Finally, If both  $R_{1,2}$  and  $R_{2,3}$  are less than 2, which indicates the gaps among the proportions of top three funding agencies are close. Among the BRIC countries India and Brazil fall into this category.

**6. Collaboration**

**Table 4: Extent of International collaboration by the BRIC Countries (Top Ten)**

BRAZIL		RUSSIA		INDIA		CHINA	
COUNTRIES	RECORDS	COUNTRIES	RECORDS	COUNTRIES	RECORDS	COUNTRIES	RECORDS
USA	11433	GERMANY	9859	USA	7043	USA	70176
FRANCE	4289	USA	9277	GERMANY	3222	AUSTRALIA	12022
GERMANY	4117	FRANCE	5394	ENGLAND	2135	JAPAN	10759
ENGLAND	3812	ENGLAND	4142	FRANCE	2019	ENGLAND	10405
SPAIN	3531	ITALY	3558	SOUTH KOREA	1865	GERMANY	10032
ITALY	2703	PEOPLES R CHINA	3161	PEOPLES R CHINA	1788	CANADA	9947
PORTUGAL	2368	SPAIN	2970	JAPAN	1542	FRANCE	5920
ARGENTINA	2176	POLAND	2615	SPAIN	1517	SINGAPORE	5642
CANADA	2175	SWITZERLAND	2591	ITALY	1446	TAIWAN	5114
PEOPLES R CHINA	1790	JAPAN	2485	RUSSIA	1377	SOUTH KOREA	4388

Table 4 shows the extent of International collaboration in funding supported SCI papers in BRIC countries. It is clearly inferred from the table that Brazil, India and China has maximum number of collaborations with USA, contributing to 11433, 7043 and 70176 records respectively. Russia has the maximum number of collaborations with Germany, contribut-

ing to 9589 records which are followed by USA, contributing to 9277 records. It is also noted that the collaboration of China with other BRIC countries are showing promise whereas the collaboration among Brazil, Russia and India are still in the early stages.

## 7. Research Areas

**Table 5: Research areas of funding-supported SCI papers in BRIC countries (Top ten)**

BRAZIL		RUSSIA		INDIA		CHINA	
RESEARCH AREAS	RECORDS	RESEARCH AREAS	RECORDS	RESEARCH AREAS	RECORDS	RESEARCH AREAS	RECORDS
Chemistry	10885	Physics	27116	Chemistry	26634	Chemistry	142975
Physics	10682	Chemistry	14554	Physics	12816	Physics	107842
Engineering	6246	Mathematics	7148	Materials science	8680	Engineering	90888
Biochemistry molecular biology	6033	Astronomy astrophysics	4769	Biochemistry molecular biology	6600	Materials science	89099
Pharmacology pharmacy	4931	Materials science	4464	Science technology other topics	4968	Science technology other topics	48661
Materials science	4849	Biochemistry molecular biology	4279	Engineering	4550	Mathematics	44251
Environmental sciences ecology	3995	Engineering	3991	Pharmacology pharmacy	4412	Biochemistry molecular biology	34642
Mathematics	3989	Geology	3435	Biotechnology applied microbiology	3028	Computer science	28184
Agriculture	3881	Optics	2916	Environmental sciences ecology	2232	Optics	25273
Science technology other topics	3764	Science technology other topics	2448	Crystallography	2139	Environmental sciences ecology	23927

Table 5 depicts the top ten research areas of funding-supported SCI papers in BRIC countries. It is clearly seen from the table that maximum number of publications in Brazil, India and China comes from the area Chemistry, contributing to 10885, 26634 and 142975 records which is followed by the area "Physics" with 10682, 12816 and 107842 records re-

spectively. In Russia the maximum number of funding-supported SCI papers comes from the area "Physics" with 27116 records followed by the area "Chemistry" with 14554 records. It clearly indicates that Chemistry and Physics are the core areas of research in the funding-supported SCI papers in BRIC countries.

## 8. Contribution of Journals

Table 6: Distribution of funding supported SCI papers in BRIC countries by top 5 Journals

COUNTRIES	JOURNALS	RECORDS	JOURNAL IMPACT FACTOR (2013)
BRAZIL	PLOS ONE	1652	3.534
	JOURNAL OF THE BRAZILIAN CHEMICAL SOCIETY	951	1.253
	ZOOTAXA	930	1.060
	PHYSICAL REVIEW D	924	4.864
	GENETICS AND MOLECULAR RESEARCH	595	0.850
RUSSIA	PHYSICAL REVIEW B	1365	3.664
	PHYSICS OF THE SOLID STATE	1304	0.782
	JETP LETTERS	1279	1.364
	PHYSICAL REVIEW D	1275	4.864
	DOKLADY EARTH SCIENCES	1233	0.495
INDIA	TETRAHEDRON LETTERS	1484	2.391
	RSC ADVANCES	1320	3.708
	PLOS ONE	1070	3.534
	PHYSICAL REVIEW D	694	4.864
	SPECTROCHIMICA ACTA PART A MOLECULAR AND BIOMOLECULAR SPECTROSCOPY	655	-
CHINA	PLOS ONE	11412	3.534
	ACTA PHYSICA SINICA	7199	0.750
	CHINESE PHYSICS B	5210	1.392
	CHEMICAL COMMUNICATIONS	4808	6.718
	APPLIED PHYSICS LETTERS	4687	3.515

Table 6 reveals the contribution of top five journals that published funding supported SCI papers in BRIC countries. It is inferred from the table that, In Brazil the journal "Plos One" has the maximum number of contribution with 1652 records, having an Impact factor of 3.534, followed by "Journal of the Brazilian Chemical Society" with 951 records with an Impact factor of 1.253. In Russia the Journal "Physical Review B" has the maximum number of publication with 1365 records with an Impact factor

of 3.664, followed by the journal "Physics of solid State" with 1304 records, having an Impact factor of 0.782. In India the Journal "Tetrahedron Letters" with an Impact factor of 2.391 has published the maximum number of publication with 1484 records, followed by the journal "RSC Advances" with 1320 records, having an Impact factor of 3.708. In China, the maximum number of contribution comes from the journal "Plos One" with 11412 records, having an Impact factor of 3.534, followed by the Journal

"Acta Physica Sinica" with 7199 records with an Impact factor of 0.750.

Among the contribution of top 5 journals in BRIC countries, it is also noted that the Journal "Chemical Communications" (ENG) has the highest Impact factor of 6.718 contributing to 4808 records in China, followed by the journal "Physical Review D" (USA) with an Impact factor of 4.864 contributing 924 records in Brazil, 1275 records in Russia and 694 record in India respectively.

## 9. Conclusion

In this study a scientometric analysis was undertaken in order to show the present state of funding supported SCI papers in BRIC countries. The findings revealed that China had published the maximum number funding supported SCI papers, contributing to 652,709 records. In the top three funding agencies, CNPQ contribute the maximum number of publications in Brazil with 35863 papers contributing to 38.87% of funding-supported SCI papers, RFBR in Russia with 60312 papers, contributing to 74.86% of funding-supported SCI papers, CSIR in India with 32676 records contributing to 42.55% of funding-supported SCI papers and in China the journal National Natural Science Foundation of China with 522,570 records contributing to 80.06% of funding-supported SCI papers. In the extent of International collaboration, Brazil, India and China had maximum number of collaborations with USA, contributing to 11433, 7043 and 70176 records respectively. Russia has the maximum number of collaborations with Germany, contributing to 9589 records which are followed by USA, contributing to 9277 records. In analyzing the major research areas, the maximum number of publications in Brazil, India and China comes from the area "Chemistry",

contributing to 10885, 26634 and 142975 records which is followed by the area "Physics" with 10682, 12816 and 107842 records respectively. In Russia the maximum number of funding-supported SCI papers comes from the area "Physics" with 27116 records followed by the area "Chemistry" with 14554 records. Among the contribution of top 5 journals in BRIC countries, it is noted that the Journal "Chemical Communications" (ENG) has the highest Impact factor of 6.718 contributing to 4808 records in China, followed by the journal "Physical Review D" (USA) with an Impact factor of 4.864 contributing 924 records in Brazil, 1275 records in Russia and 694 record in India respectively. Based on the findings it is concluded that Single funding agency dominates funding supported SCI papers in Russia and China, whereas on the other hand, funding sources are diversified in India and Brazil which means there is no much difference among the contribution of funding agencies.

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