

Research Collaboration between India and Turkey: a Scientometric Study

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Abstract

The paper attempts to evaluate the research collaboration between India and Turkey on the basis of research articles published with author address from these countries during 2009-2013 and indexed in Web of Science-Science Citation Index Expanded online database. Out of a total of 330,071 records of both the countries for the period; 966 records were found to be in joint collaborative authorship from the researchers from both the countries. A scientometric assessment of the collaboration of research articles has been presented in the study by analyzing; annual output of research articles in collaboration from Turkey and India, leading partners in research from Turkey, India and other countries, preferred areas of research, prolific institutions, top ranked journals preferred and language of the publications. The study may be useful to subject specialists, analysts, researchers, students, policy makers, administrators and faculty of both the countries to look into effective collaborations in the research.

Keywords: India; Turkey; Scientific collaboration; Scholarly output; Scientometric analysis; Collaborative research; Mapping research

Introduction

India and Turkey share very cordial relations and there are many academic areas where there is a scope for the further improvement. Indian economic growth and its increasing relevance in international arena is inviting the attention of other countries and the Turkey is not an exception to this. Turkey has begun to view India as possible source of Information Technology and a useful economic partner. The Indian Space Research Organisation (ISRO) had sent Turkey's first nano-satellite to space on 23rd September 2009. Turkey is keen to expand cooperation in space technology with India. There are a number of Indian nationals in Turkey and they are working in

commercial organizations, banks, computer firms, educational institutions, etc. Relations in the field of science and engineering are developing and this relationship resulting in some research articles which has been taken as the subject of this present study (http://www.mea.gov.in/Portal/ForeignRelation/India-Turkey_Relations.pdf).

Review of Literature

Literature review shows that few studies have already been conducted on related areas. De Moya-Anegón and Herrero-Solana (1999) in their study compared six Latin American countries with Southwest Asia and found strong links between South America and Spain and also with the USA. Basu and Kumar (2000) made an assessment of Indian collaborative papers and revealed that between 1990 and 1994, there has been about 40% increase in internationally co-authored papers from India but less than the growth rate of collaborative papers worldwide. Total output of papers grew from 10 to 14 percent and USA was the major partner to India. There were 33% Indian papers in collaboration with USA which remained stable in 1980s and 1990s and decreased to 29% in 1994. Glänzel and De Lange (2002) revealed in their study that the ratio of the number of international links and international papers is roughly proportional to the ratio of full and fractional publication counts. In other words, the relationship between international links and international papers is expressed by the relationship between full counts and fractional publication counts and vice versa. Hussain (2011) in his study talks about the India and Turkey relations in various perspectives. Al et al. (2012) in their study found that Turkey addressed publications were produced mostly with the collaboration of multiple authors which were generally limited in the country. Due to these reasons, most of the Turkey addressed scientific works could be counted as domestic publications. Having examined the scientific fields individually, it was also observed that in general, most of the fields also exhibit a tendency of multiple authorship.

Objectives

The objectives of the study aimed to evaluate the trend of research output of these two countries on the basis of research articles indexed in Web of Science by way of analyzing the following features of publications of the study period:

- i) Annual output of research articles in collaboration from Turkey and India.
- ii) Leading partners in research.
- iii) Preferred areas of research.
- iv) Prolific institutions
- v) Top ranked journals preferred.

Data Source and Methodology

This study is a scientometric analysis of research articles produced by India and Turkey. The data for this study was obtained from the Web of Science-Science Citation Index Expanded (WoS) database of Thomson Reuter for a period of five years from 2009 to 2013. The study has been confined to scholarly output in terms of research articles. The Advance Search option was used and research articles having author address of Turkey and India were selected for the desired results with restricted period of 2009-2013. In order to obtain the results and for drawing inferences, data was retained as MS Excel files. The data was refined, analysed and inferences were drawn using Excel as per the objectives of the study (<http://apps.webofknowledge.com>).

Analysis and Discussion

Research articles from Turkey and India

Annual output of research articles

During five years period; research articles jointly published from Turkey and India were 330071. The individual country share of articles was 110025 (33.33%) of Turkey and 220046 (66.67%) of India. The table 1 shows continual increasing trend in output of research articles. The increased output of research articles was 57799 (17.51%) in 2009, 61714 (18.70%) in 2010, 66154 (20.04%) in 2011, 69593 (21.08%) in 2012 and 74811 (22.67%) in 2013. The average output of research articles was 6614.2 articles every year.

Data of individual country's output of research articles was analyzed and observed increased output of research articles. In respect of Turkey, the output of research articles was 20211 (18.37%) in 2009, 20973 (19.06%) in 2010, 21559 (19.60%) in 2011, 23083 (20.98%) in 2012

and 24199 (21.99%) in 2013. The average output of research articles was 2205 articles every year. The research article output of Turkey was increased by 16.18% after five years.

The research articles in respect of India were 37588 (17.08%) in 2009, 40741 (18.52%) in 2010, 44595 (20.27%) in 2011, 46510 (21.14%) in 2012 and 50612 (23.00%) in 2013. The average output of research articles was 4409.2 articles per year. The research article output of India was increased by 25.23% after five years.

<i>Year</i>	<i>Turkey & India</i>	<i>Percentage</i>	<i>Turkey</i>	<i>Percentage</i>	<i>India</i>	<i>Percentage</i>
2009	57799	17.51	20211	18.37	37588	17.08
2010	61714	18.70	20973	19.06	40741	18.52
2011	66154	20.04	21559	19.60	44595	20.27
2012	69593	21.08	23083	20.98	46510	21.14
2013	74811	22.67	24199	21.99	50612	23.00
	330071	100.00	110025	100.00	220046	100.00

Ranking research partners

Data of research articles from both Turkey and India was analyzed to know the major partners of research and presented in table 2. In respect of Turkey, the USA was on top in the list of research partners with 7537 (6.85%) research articles followed by Germany with 3186 (2.90%), UK with 2555 (2.32), Italy with 2241 (2.04%) and France was at fifth position with 2066 (1.88%).

India had USA at top with collaboration in 14914 research articles (6.78%) followed by Germany with 5908 (2.69%), UK with 4712 (2.14%), South Korea with 4529 (2.06%) and France with 4145 (1.88%). Turkey was at 26th position in the list of partners to India though India was at 19th position in the list of partners of Turkey.

<i>Ran k</i>	<i>Turkey</i>			<i>India</i>		
	<i>Country</i>	<i>Article s</i>	<i>Percentag e</i>	<i>Country</i>	<i>Article s</i>	<i>Percentag e</i>
1	USA	7537	6.85	USA	14914	6.78
2	Germany	3186	2.90	Germany	5908	2.69
3	UK	2555	2.32	UK	4712	2.14
4	Italy	2241	2.04	South Korea	4529	2.06
5	France	2066	1.88	France	4145	1.88
6	Spain	1665	1.51	Japan	3594	1.63

7	Netherlands	1374	1.25	China	2948	1.34
8	Switzerland	1317	1.20	Canada	2775	1.26
9	China	1297	1.18	Italy	2713	1.23
10	Canada	1274	1.16	Australia	2565	1.17
11	Greece	1202	1.09	Spain	2219	1.01
12	Russia	1134	1.03	Taiwan	1852	0.84
13	Poland	1128	1.03	Malaysia	1837	0.84
14	Austria	1090	0.99	Switzerland	1721	0.78
15	Iran	1073	0.98	Russia	1685	0.77
16	Romania	1061	0.96	Saudi Arabia	1601	0.73
17	Japan	1003	0.91	Netherlands	1566	0.71
18	Czech Republic	966	0.88	Brazil	1539	0.70
19	India	966	0.88	Poland	1439	0.65
20	Belgium	926	0.84	Sweden	1365	0.62
				Turkey is at 26 th position	966	0.44

Research areas of Turkey and India

Table 3 depicts the data of top twenty preferred subject areas of research in Turkey. Engineering topped the list with 14025 (12.75%), followed by Chemistry with 9044 (8.22%), Material Science with 7329 (6.66%), Physics with 7088 (6.44%) and Surgery with 5719 (5.20%).

An overview of the research subjects preferred by India has been presented in table 3. Chemistry topped with 45149 (20.52%) research articles followed by Physics with 30512 (13.87%), Engineering with 25259 (11.48%), Materials Science with 24090 (10.95%) and Pharmacology Pharmacy with 11746 (5.34%).

Table 3. Top twenty research areas of Turkey and India					
<i>Turkey</i>			<i>India</i>		
<i>Area of research</i>	<i>Articles</i>	<i>Percentage</i>	<i>Area of research</i>	<i>Articles</i>	<i>Percentage</i>
Engineering	14025	12.75	Chemistry	45149	20.52
Chemistry	9044	8.22	Physics	30512	13.87
Materials Science	7329	6.66	Engineering	25259	11.48
Physics	7088	6.44	Materials Science	24090	10.95
Surgery	5719	5.20	Pharmacology Pharmacy	11746	5.34
Mathematics	5517	5.01	Science Technology Other Topics	11265	5.12

General Internal Medicine	5252	4.77	Biochemistry Molecular Biology	10479	4.76
Environmental Sciences Ecology	4372	3.97	Agriculture	10085	4.58
Computer Science	4052	3.68	Environmental Sciences Ecology	8133	3.70
Neurosciences Neurology	3788	3.44	Biotechnology Applied Microbiology	7203	3.27
Veterinary Sciences	3526	3.21	Mathematics	7202	3.27
Pediatrics	3303	3.00	Plant Sciences	5442	2.47
Agriculture	3221	2.93	Computer Science	5187	2.36
Cardiovascular System Cardiology	3203	2.91	Polymer Science	4676	2.13
Pharmacology Pharmacy	3064	2.79	Optics	4495	2.04
Food Science Technology	2898	2.63	Crystallography	4033	1.83
Biochemistry Molecular Biology	2588	2.35	Metallurgy Metallurgical Engineering	3946	1.79
Energy Fuels	2587	2.35	Microbiology	3923	1.78
Oncology	2274	2.07	Astronomy Astrophysics	3845	1.75
Science Technology Other Topics	2174	1.98	Mechanics	3811	1.73

Prolific institutions of Turkey

The data was analysed for identification of prolific institutions and list of top twenty prolific institutions of Turkey is presented in table 4. The Istanbul University topped the list with 6796 (6.18%), followed by Ege University with 5735 (5.21%), Hacettepe University with 5708 (5.19%), Gazi University with 5387 (4.90%) and Ankara University with 5339 (4.85%). Almost all the institutions in top twenty are academic institutions.

The data was also analysed for identification of prolific institutions from India and list of top twenty prolific institutions is presented in table 4. The Indian Institutes of Technology occupied

first position by producing 26366 (11.98%) research articles followed by the Council of Scientific and Industrial Research with 23517 (10.69%), the Indian Institute of Science with 7094 (3.22%), Bhabha Atomic Research Center with 5880 (2.67%) and Banaras Hindu University with 4497 (2.04%). Top twenty institutions produced 48.35% research articles during the period of five years.

Table 4. Prolific institutions of research articles from Turkey and India

<i>Turkey</i>			<i>India</i>		
<i>Institution</i>	<i>Articles</i>	<i>Percentage</i>	<i>Institution</i>	<i>Articles</i>	<i>Percentage</i>
Istanbul University	6796	6.18	Indian Institute of Technology	26366	11.98
Ege University	5735	5.21	Council of Scientific and Industrial Research	23517	10.69
Hacettepe University	5708	5.19	Indian Institute of Science	7094	3.22
Gazi University	5387	4.90	Bhabha Atomic Research Center	5880	2.67
Ankara University	5339	4.85	Banaras Hindu University	4497	2.04
Orta Dogu Teknik University	4501	4.09	University of Delhi	3975	1.81
Istanbul Teknik University	3913	3.56	All India Institute of Medical Sciences	3382	1.54
Selcuk University	3668	3.33	Jadavpur University	3382	1.54
Ataturk University	3614	3.29	Tata Institute of Fundamental Research	3103	1.41
Erciyes University	3422	3.11	Anna University	2651	1.21
Dokuz Eylul University	3030	2.75	Panjab University	2614	1.19
Ondokuz Mayıs University	2879	2.62	Aligarh Muslim University	2512	1.14
Cukurova University	2740	2.49	University of Calcutta	2485	1.13
Marmara University	2603	2.37	Anna University Chennai	2347	1.07
Suleyman Demirel University	2566	2.33	Indian Association for the Cultivation of Science	2191	1.00
Karadeniz Teknik University	2524	2.29	Centre National De La Recherche	2163	0.98

			Scientifique (CNRS)		
Uludag University	2408	2.19	PGIMER Chandigarh	2140	0.97
Firat University	2393	2.18	Annamalai University	2122	0.96
Gulhane Askeri Tip Akademisi Gata	2368	2.15	University of Hyderabad	2027	0.92
Akdeniz University	2247	2.04	University of California System	1943	0.88

Collaborated Articles of Turkey and India

Table 5 shows the growth of research articles published in collaboration between researchers of Turkey and India. Out of a total of 330071 records of both the countries for the period; 966 records were found to be in joint collaborative authorship from the researchers from both the counties which is 0.88% of Turkish and 0.44% of Indian article output for five years. In 2009, there were 74 (7.66%) research articles published in joint authorship from Turkey and India. The year 2010 recorded considerable increase of 47.89% by publishing 142 (14.70%) articles. The 2011 had 189 articles (19.57%) which again is an increase of 24.87% over 2010. During the year 2012, the output further increased to 269 (27.85%) with an increase of 29.74% over 2011. In the year 2013, collaborated research articles increased to 292 (30.23%) with an increase of 7.88% over 2012 but this year saw a drastic decrease in percentage over previous years. The reason for this decrease may also be due to late indexing of journals. It is expected that if the data would be retrieved with the same parameters after two years period then it will certainly be higher than present data. The increasing trend of collaborated research between Turkey and India is depicted in figure 1.

<i>Year</i>	<i>Number of research articles</i>	<i>Percentage</i>	<i>Percent change</i>
2009	74	7.66	0.00
2010	142	14.70	47.89
2011	189	19.57	24.87
2012	269	27.85	29.74
2013	292	30.23	7.88

Research areas of Turkey and India

Data of joint research articles by the partners from Turkey and India was analysed to identify leading areas of research and presented in table 6. Physics was at top with the output of 400 (41.41%) research articles followed by Mathematics with 111 (11.49%), Spectroscopy with 69 (7.14%), Astronomy Astrophysics with 55 (5.69%) and Chemistry with 50 (5.18%) research articles.

<i>Area of research</i>	<i>Articles</i>	<i>Percentage</i>
Physics	400	41.41
Mathematics	111	11.49
Spectroscopy	69	7.14
Astronomy Astrophysics	55	5.69
Chemistry	50	5.18
Engineering	49	5.07
Crystallography	46	4.76
Instruments Instrumentation	37	3.83
Materials Science	26	2.69
Computer Science	24	2.48
Science Technology Other Topics	22	2.28
Infectious Diseases	15	1.55
General Internal Medicine	14	1.45
Genetics Heredity	14	1.45
Pharmacology Pharmacy	14	1.45
Environmental Sciences Ecology	12	1.24
Geology	12	1.24
Nuclear Science Technology	10	1.04
Plant Sciences	10	1.04
Water Resources	10	1.04

Institutions collaborated in research articles for Turkey and India

University of California System with 378 (39.13%), Russian Academy of Sciences with 375 (38.82%), United States Department of Energy with 370 (38.30%), Istituto Nazionale Di Fisica Nucleare with 368 (38.10%) and Hungarian Academy of Sciences with 366 (37.89%) respectively were the top five collaborating institutions from the globe during the period which has been depicted in table 7.

<i>Institution</i>	<i>Articles</i>	<i>Percentage</i>
University of California System	378	39.13
Russian Academy of Sciences	375	38.82
United States Department of Energy	370	38.30
Istituto Nazionale Di Fisica Nucleare	368	38.10
Hungarian Academy of Sciences	366	37.89
Sapienza University Rome	364	37.68
University of Athens	364	37.68
Alikhanov Institute for Theoretical Experimental Physics	359	37.16
European Organization for Nuclear Research CERN	359	37.16
Ohio State University	359	37.16
Yerevan Physics Institute	358	37.06
CEA	357	36.96
Centre National De La Recherche Scientifique (CNRS)	356	36.85
Lomonosov Moscow State University	352	36.44
University of Bologna	350	36.23
University of Belgrade	343	35.51
Purdue University	341	35.30
Panjab University	338	34.99
Wayne State University	337	34.89

Partner countries of joint research articles from Turkey and India

Data of the joint research articles of Turkey and India was analyzed to know the major partners of research and presented in table 8. The USA was number one with 498 (51.55%), followed by UK with 433 (44.82%), Germany with 425 (44.00%), France with 421 (43.58%) and China with 416% research articles.

<i>Country</i>	<i>Articles</i>	<i>Percentage</i>
USA	498	51.55
UK	433	44.82
Germany	425	44.00
France	421	43.58
China	416	43.06
Brazil	412	42.65
Italy	412	42.65
Spain	411	42.55
Poland	404	41.82

Russia	390	40.37
Greece	388	40.17
Switzerland	379	39.23
Hungary	377	39.03
Mexico	372	38.51
Austria	368	38.10
South Korea	368	38.10
Armenia	361	37.37
Serbia	358	37.06
Finland	355	36.75
Croatia	345	35.71

Journals published joint research articles

The data was analyzed to identify prolific journals those published joint research articles by researchers from Turkey and India and is presented in table 9. The Journal of High Energy Physics topped with 103 (10.66%) joint research articles of Turkey and India followed by Physics Letters-B with 87 (9.01%), Physical Review Letters with 66 (6.83%), Spectrochimica Acta Part-A with 62 (6.42%) and Acta Crystallographica Section-E with 44 (4.56%).

Table 9. Top twenty journals published joint research articles from Turkey and India		
<i>Name of Journal</i>	<i>Articles</i>	<i>Percentage</i>
Journal of High Energy Physics	103	10.66
Physics Letters B	87	9.01
Physical Review Letters	66	6.83
Spectrochimica Acta Part-A	62	6.42
Acta Crystallographica Section-E	44	4.56
Physical Review-D	38	3.93
European Physical Journal-C	33	3.42
Journal of Instrumentation	33	3.42
Journal of Molecular Structure	18	1.86
Astronomy Astrophysics	9	0.93
Applied Mathematics and Computation	8	0.83
Applied Mathematics Letters	8	0.83
International Journal of Theoretical Physics	7	0.73
Abstract and Applied Analysis	6	0.62
Filomat	6	0.62
Journal of Applied Mathematics	6	0.62
Hacettepe Journal of Mathematics and Statistics	5	0.52
Infection Control and Hospital Epidemiology	5	0.52
Journal of Inequalities and Applications	5	0.52
Journal of Raman Spectroscopy	5	0.52

Findings and Conclusions

- i) Turkey and India have published 330071 research articles with individual share of Turkey was 110025 (33.33%) and 220046 (66.67%) research articles were from India. Out of a total records of both the countries for the period; 966 records were found to be in joint collaborative authorship from the researchers from both the counties.
- ii) The average output of research articles was 6614.2 articles per year.
- iii) The research article output of Turkey was increased by 16.18% after five years though India recorded an increase of 25.23% after five years.
- iv) Turkey published 95.56% and India 99.98% research articles in English language.
- v) USA has been the preferred partner in research by both the countries by collaborating in 6.85% articles with Turkey and 6.78% articles with India.
- vi) USA has also been the most preferred partner in combined articles by collaborating in 51.55% research articles.
- vii) Most preferred area of research has been Engineering in Turkey with 12.75% and Chemistry in India with 20.52% output of research articles.
- viii) Physics was highly preferred area of research with 41.41% output in collaborated research articles of Turkey and India.
- ix) The Journal of High Energy Physics published 10.66% joint articles of Turkey and India.
- x) Istanbul University was the most prolific institution of Turkey with 6.18% research articles and Indian Institutes of Technology with 11.98% research articles was at top from India but it was surprising to note that University of California, USA was the most prolific institution in joint research articles.
- xi) Collaborated research articles were increased by 125.34% in five years.

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