

Assessing the Research Impact of Institutions in India: A Bibliometrics Analysis Using Thomson Reuters InCites

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Abstract

In this study, a comparative bibliometric analysis of the research performance assessment of certain academic organizations in India is presented over a period of 35 years, using Thomson Reuters InCites research evaluation tool. Various aspects of research performance are assessed using bibliometrics analysis. Firstly, at the national level, India's (and other BRIC countries') trends in output and India's global share of output in selected scientific fields over time are presented. Secondly, at the institutional level, India's selected top academic institutions and universities are assessed upon their national share of output, change in normalized field performance over time, normalized performance in the field they publish the most and what is the impact of their international collaborations on average citation rates. Additionally, a case study on the international collaborations of the Jadavpur University over the past 20 years is presented.

Keywords: Bibliometrics, InCites, India, Institutional Productivity, Web of Science

1. Introduction

The growth of publication activity in emerging economies such as China and India, both important members of the so called 'BRIC' (Brazil, Russia, India and China) group of countries, has strongly impacted the global scientific landscape. China has become an important global economic power and has developed a systematic and growing publication strategy in the fields of science and technology. Similarly India during the last decade has become a leading country in terms of its global share of scientific output. India has achieved a remarkable increase in the production of scientific output over the last 20 years combined with enhanced economic activity. This study focuses specifically on investigating the evolution of India's research performance particularly at the organizational level and how selected universi-

ties have performed in terms of their national share of research output, normalized field performance and international collaboration patterns.

Various studies assessing the research performance of the scientific research output of India and China have been presented. It is observed that in recent years China has become a leading country in the sciences. China plays a major role in critical technologies such as nanoscience and nanotechnology, achieving a position second only to the United States of America. China is the fifth leading country for its share of global scientific publications and the citation rate of papers with Chinese addresses for corresponding authors has grown exponentially. Funding for Chinese research and development has also been growing exponentially. Since 1997 more funding has come from businesses and the private sector than from government expenditure (Zhou and Leydesdorff, 2014). It has been found that the Chinese government has been effective at utilizing pub-



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lic sector research potential to boost the knowledge based national economy by achieving the 'Lisbon' objective of the transition to a predominantly knowledge based economy more rapidly than its western counterparts. Due to the virtually unlimited reservoir of highly skilled human resources, a continuation of the Chinese growth pattern is expected in the near future (Zhou and Leydesdorff, 2014).

A performance analysis of India's research output in the fields of science and technology, using publications data and quantitative and qualitative measures over the period 1996-2010 has been recently produced (Gupta, 2012). This research focused on India's global publication share, rank, growth rate, citation quality, collaborative publications, publication share and distribution in various subjects. The research also investigated the increased pace of scientific research in India, its improving quality, built up scientific capacity, competence and knowledge base for bridging scientific and technological gaps with leading countries.

Glanzel and Gupta (2008) presented an analysis of India's research output in the fields of science and technology using its publication output in peer reviewed international journals covered in the Web of Science database and analyzed India's publication activities in terms of global share, visibility, citation impact and the share of international collaborative publications during 1991-2006. The research explored how far the trends in India's research output for science and technology compare to those of other countries and the main differences among the countries.

An analysis of India's publication output in three major international databases as indexed during the period 1981-2005 has been conducted. The study reports on India's comparative strength in interna-

tional science and technology output, growth, strong and weak subject areas of research, media of communication, institutional productivity and quality of research output and dynamics of India's research at various levels (Gupta and Dhawan, 2008).

A similar analysis of growth and development of India's research output in the fields of science and technology as reflected in publication output covered by Science Citation Index during 1990-2004 has been presented (Kademani et al., 2007). This research study focused on the characteristics of India's publication growth, language, format, media of communication, research quality, institutional productivity, patterns of research collaboration and other related subject areas. Additionally a comparison of India's research output with selected countries including China has also been presented.

2. Data Sources and Methodology

The bibliometric analysis presented in this study is based on Thomson Reuters InCites research evaluation tool. InCites covers publications from Web of Science Core Collection including journals, books and conference proceedings in all areas of science, social sciences and arts & humanities. In the presented analysis all publication types are included (journals, books and conference proceedings), unless stated otherwise. Bibliometric indicators and national benchmarks used in this study are all calculated by Thomson Reuters InCites.

In the presented study, a class of basic (absolute) and advanced normalized bibliometric indicators, deemed appropriate for institutional benchmarking and research performance evaluation at various levels (e.g. institution, national, international) are used, including the number of research output, numbers of citations, average citations per publications, cat-

egory normalized citation impact and % of international collaborations.

In this study, wherever analysis per discipline is given, the Thomson Reuters Essential Science Indicators (ESI) subject classification schema is used. The ESI subject schema classification includes 22 broad fields in the sciences and social sciences, in which journals are assigned uniquely under a category. In order to identify shifts in the patterns of research performance in India's institutional output, a 35 time year period is used, from 1980 to 2015, as well as indicative moving time periods.

The International Collaborations indicator shows the number of publications that have been found with at least two different countries among the affiliations of the co-authors. The International Collaborations indicator can be applied to any level of aggregation (author, institution, national, journal or field). The definition of an internationally collaborative document is a relatively simple indicator that only takes into account if a document is international (two or more countries) or not. It does not take into account the total number of countries represented in the publication (InCites Indicator Handbook, 2014).

3. Statistical Analysis and Numerical Results

3.1 Global Share of Scientific Productivity

Figure 1 shows an overview of the trends in research output of BRIC countries (Brazil, Russia, India and mainland China) for the period 1980-2014. China has seen high growth in the production of research output from 2000 onwards achieving an increase in its productivity from 2010 (193,754 publications) to 2011 (239,948 publications) of some 46,194 publications. India follows, seeing a steady increase in the

production of research output from 1995 onwards. After 2004, there is a larger increase of more than 5,000 publications per year during 2005-2008 and 2001-2012. Russia's research output experienced a growth in productivity from 1992 to 1999, overtaking China, India and Brazil however from 2000 onwards Russia was unable to match the same pace as the other countries under assessment in terms of publication production. Brazil overtook Russia, from 2007 onwards, but was positioned in 3rd place after China (1st) and India (2nd) in 2013.

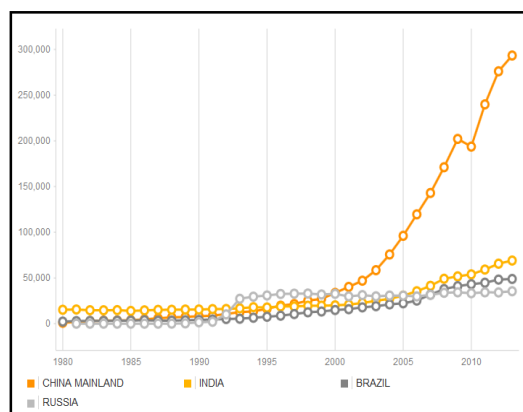
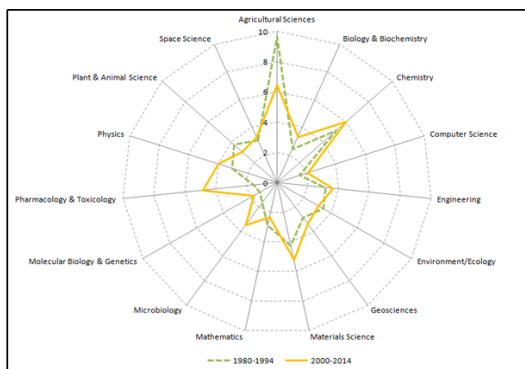


Figure 1: Overview of the development of BRIC countries total research output during the period 1980-2013

Figure 2 shows a comparative analysis of India's global share of research output over the past 35 years in selected ESI broad scientific fields. During 1980-1994 and 2000-2014, India's highest percentages of global research output are both in Agricultural Sciences and Chemistry. India holds 9.7% of the global research output in Agricultural Sciences and 5.2% in Chemistry from 1980-1994 however in 1990-2014, this share dropped to 6.5% in Agricultural Sciences and 6% in Chemistry. During 2000-2014, India's largest percentage increase in the share of global scientific output was 3.3% in the field of Pharmacology &

Toxicology (4.84% from 1.51%) and 1.82% in Microbiology (3.46% from 1.64%).

Other scientific fields in which India experienced growth (of less than 1%) in 2000-2014 were 0.97 in Material Sciences (5.24% from 4.26%), 0.91 in Physics (3.97% from 3.06%), 0.87 in Biology & Biochemistry (3.31% from 2.44%), 0.83% in Chemistry (6% from 5.17%), 0.52% in both Engineering (3.64% from 3.13%) and Computer Science (2.06% from 1.55%), 0.49% in Geosciences (3.38% from 2.88%), 46% in Molecular Biology and Genetics (1.72% from 1.26%) and 0.23% in Space Science (3.29% from 3.06%). The largest decline in global share of research output in 2004-2014, when compared to 1980-1994, was 3.2% in Agricultural Sciences. Other fields in which India global share of output experienced a decline (of less than 1%) in 2000-2014, are 0.72% in Plant & Animal Science (3.02% from 3.74%), 0.52% in Mathematics (2.34% from 2.86%), and 0.38% in Environment/Ecology (3.08% from 3.46%).



Graph 2: India's change in global share of output in selected ESI disciplines in 1980-2014

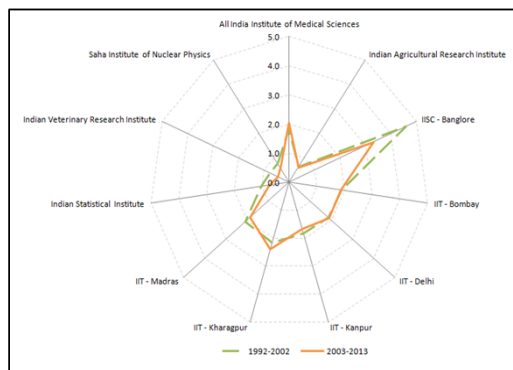
3.2 National Share of Research Output

The national performance of India, in terms of research output, can be measured at the institutional level. Graphs 3 and 4 show a long term analysis of

the national share of India's research output over a 20 year period, using two 10-year time windows.

Graph 3 shows the change in the national percentage share of India's selected top performing performing universities in 1992-2002 in comparison to 2003-2013.

During 2003-2013, All India Institute of Medical Sciences and IIT Kharagpur both presented a growth of 0.23% in their national share of output. All India Institute of Medical Sciences went from 1.81% in 1992-2002 to 2.04% in 2003-2013 while IIT Kharagpur went from 2.17% in 1992-2002 to 2.4% in 2003-2013. IIT Delhi and IIT Bombay presented no significant growth or decline, while IISC Bangalore dropped by a 1.29% (3.32% from 4.60%). Other institutes that presented a decline of less than 1% in their share of national output is 0.32% by the Indian Statistical Institute (0.7% from 1.03%), 0.3% by the Indian Veterinary Research Institute (0.46 from 0.76), 0.22 by IIT Madras (1.85% from 2.07%), 0.17% by both Saha Institute of Nuclear Physics (0.59% from 0.77%) and IIT Kanpur (1.67% from 1.83%) and 0.03% by the Indian Agricultural Research Institute (0.60 from 0.63%).

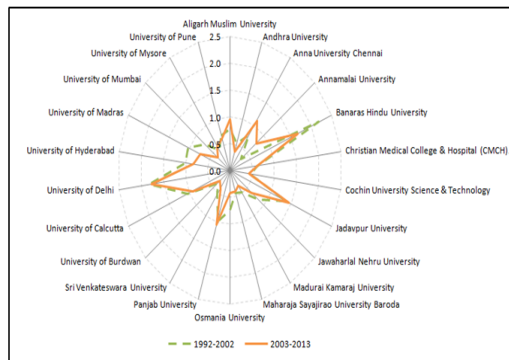


Graph 3: Change in share of national output for selected academic institutions of India for 1992-2013

Graph 4 shows the change in the national percentage share of India's selected top performing universities during 1992-2002 in comparison to 2003-2013. In 2003-2013 the largest share of national output was held by University of Delhi with 1.77%, followed by Banaras Hindu University with 1.66% and Jadavpur University with 1.45%. During 2003-2013 the following universities presented a growth on the share of national output, from largest to smallest; Annamalai University by 0.45% (0.77% from 0.32%), Anna University Chennai by 0.32% (1.11% from 0.79%), Aligarh Muslim University by 0.19% (0.96% from 0.77%), Jadavpur University by 0.08% (1.45% from 1.38%), both University of Mysore (0.52% from 0.45%) and Panjab University (1.05% from 0.98%) by 0.07% and Christian Medical College & Hospital (CMCH) Vellore marginally by 0.02% (0.62% from 0.60%).

The universities that presented the largest decline in their share of national output are Banaras Hindu University by 0.52% (1.66% from 2.18%), followed by University of Mumbai by 0.36% (0.37% from 0.73%) and Osmania University by 0.33% (0.42% from 0.75%). Other universities that have presented a decline between 0.3% and 0.10% are University of Madras by 0.30% (0.73% from 1.03%), Jawaharlal Nehru University by 0.20% (0.64% from 0.84%), University of Hyderabad by 0.17% (0.83% from 1.01%), Andhra University by 0.16% (0.37% from 0.53%), Madurai Kamaraj University by 0.15% (0.33% from 0.48%), Sri Venkateswara University by 0.14% (0.41% from 0.54%) and University of Calcutta by 0.13% (0.92% from 1.05%). Marginal drop was identified by University of Burdwan by 0.07% (0.29% from 0.36%), University of Pune by 0.06% (0.62% from 0.60%), University of Delhi by 0.05% (1.77% from

1.83%), and last both by Maharaja Sayajirao University Baroda (0.41% from 0.44%) and Cochin University Science & Technology (0.43 from 0.46%) by 0.03%



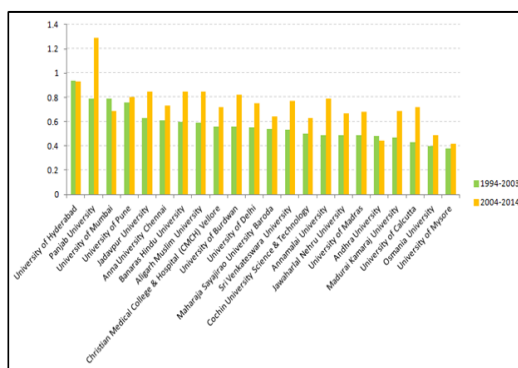
Graph 4: Change in share of national output for selected universities of India for 1992-2013

3.3 India's Universities Field Normalized Performance Over Time

A characteristic of India's institutional output is its fast rate of growth. Important aspects of research performance at the international level include publication output and citation rates. At the institutional level, citation rates can be measured (Aksnes & Sivertsen, 2009) and should be normalized especially for comparative purposes because average citation rates vary significantly across different fields, citations grow over time and need to be compared in the same time windows and finally different publication types have different citation rates (Mingers & Lipitakis, 2013).

An important bibliometric indicator for assessing institutions and which takes into account differences in the subject mix and size of an institution; and which is very often used for institutional benchmarking, is the Category Normalized Citation Impact (CNCI) indicator. The CNCI indicator is cal-

culated by dividing the actual count of citing items by the expected citation rate for publications with the same document type, year of publication and subject area (InCites Indicator Handbook, 2014). If the CNCI exceeds the value of 1, this indicates that the institution is performing above the world average. Alternatively if it is below the value of 1, this indicates that the institution is performing below the world average. Graph 5 shows the change in the CNCI indicator for selected top universities in India during the period 1994-2014, using two 10-year time periods for comparative purposes.



Graph 5: Change in Category Normalized Citation Impact for 22 top university's in India

Graph 5 shows an overall steady growth in the field performance of India's selected universities during 2004-2014 when compared with the institutional field performance during 1994-2003. Despite the growth and increasing rate of performance over the past ten years, the selected universities are performing under the global average with the exception of Panjab University, which is performing over the global average.

3.4 International collaborations and average citation rates in Chemistry

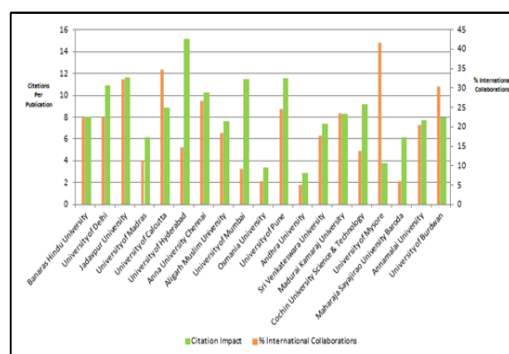
As previously stated for institutional benchmarking, some important aspects of research performance include publication output and citation rates particularly the normalized citation rates, i.e. the Category Normalized performance. Table 1 shows the Essential Science Indicators (ESI) categories within which the examined universities publish most frequently and their corresponding number of publications and citations for 2004-2013.

Table 1: India's Universities Breakdown Per ESI Subject category they Mostly Publish

2004-2013			
University	ESI field that University publishes the most	Number of Documents	Times Cited
Christian Medical College & Hospital (CMCH) Vellore	Clinical Medicine	1,915	10,473
Jadavpur University	Chemistry	1,750	20,389
Panjab University	Physics	1,676	40,675
University of Delhi	Chemistry	1,579	17,170
Banaras Hindu University	Chemistry	1,375	11,062
University of Hyderabad	Chemistry	1,255	19,074
Anna University Chennai	Chemistry	1,255	12,879

University of Madras	Chemistry	1,231	7,634
University of Mysore	Chemistry	1,198	4,547
University of Calcutta	Chemistry	1,076	9,498
Annamalai University	Chemistry	1,037	8,005
Aligarh Muslim University	Chemistry	941	7,194
University of Mumbai	Chemistry	839	9,595
Madurai Kamaraj University	Chemistry	711	5,863
University of Pune	Chemistry	662	7,639
Sri Venkateswara University	Chemistry	603	4,479
University of Burdwan	Chemistry	556	4,437
Andhra University	Chemistry	516	1,510
Osmania University	Chemistry	502	1,698
Maharaja Sayajirao University Baroda	Chemistry	462	2,852
Cochin University Science & Technology	Chemistry	429	3,950
Jawaharlal Nehru University	Biology & Biochemistry	412	4,083

Table 1 shows that 19 out of 22 universities primarily publish in Chemistry. In the case of India's selected universities, it is interesting to compare the average citation rate in Chemistry, Chemistry being the broad discipline in which they publish the most, in relation to their percentage of international collaborations. International collaborations are considered to be a way to develop and disseminate scientific knowledge and a driver of scientific impact (number of citations). Internationally co-authored documents gain more visibility in the global scientific community and tend to receive more citations therefore increasing the citations per publication indicators.



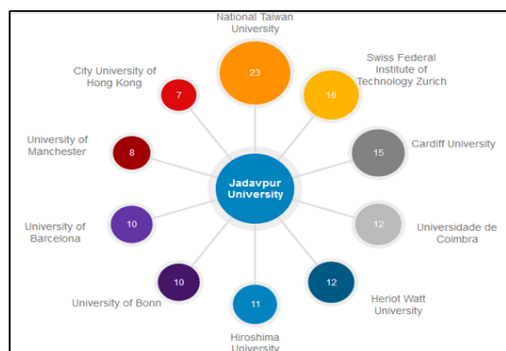
Graph 6: Citation per publication and % of international collaborations for India's universities in Chemistry in 2004-2013

Graph 6 shows the impact of international collaborations and the average citation rates of India's selected universities that publish mostly in the field of Chemistry. The average citation rate ranges from 15.2 – 2.93, while the percentage of international collaborations ranges from 41.65 - 5.04. The results provided by this analysis are somewhat inconsistent. Graph 3 shows that a higher percentage of in-

ternational collaborations does not always drive the scientific impact of universities in a given field. For example, University of Hyderabad has the highest average citation rate (15.2) however the percentage of its international collaborations is not very high (14.74). University of Mysore has the highest percentage of international collaborations (41.65) while the citation per publications indicator is somewhat low (3.8). Although India's research impact clearly benefits from international collaborations (Glanzel & Gupta, 2008) in order to understand better India's international collaboration landscape at the institutional level, further analysis of the collaboration patterns of institutions is required. In the next section, a case study assessing the international collaboration patterns of Jadavpur University is given.

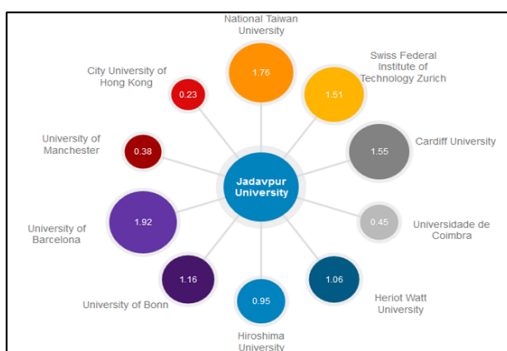
3.5 Scientific Collaborations: The Case of Jadavpur University

Graph 5 showed an increase in Jadavpur University's category normalized citation impact indicator between 1994-2003 and 2004-2013 from 0.63 to 0.85. In this section the collaboration patterns of Jadavpur University will be investigated during 1994-2003 and compared with those for 2004-2013, in order to investigate the impact of collaborations on the overall research performance assessment of a given organization. Graph 7 shows the top 10 international collaborations of Jadavpur University in terms of the number of documents with other organizations outside of India during 1994-2003. The highest number of international collaborations is with National Taiwan University (23), followed by the Swiss Federal Institute of Technology (16) and Cardiff University (15).

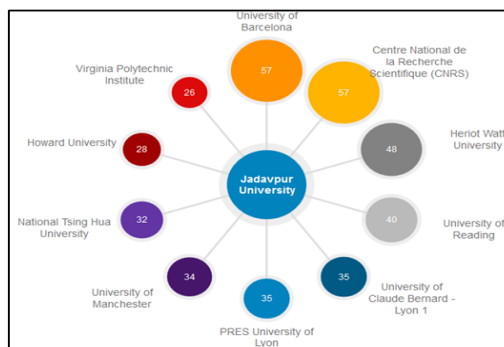


Graph 7: Jadavpur University's top 10 international collaboration in terms of output in 1994-2003

Graph 8 shows the category normalized performance of the top 10 international collaborations of Jadavpur University during 1994-2003. It can be seen that the 10 documents that Jadavpur university has published in collaboration with University of Barcelona have performed almost two times better than the average publication. It would be interesting to see whether Jadavpur University pursued more collaborations with University of Barcelona during 2004-2013, given that the pair performed very well during the period 1994-2003 (Graph 9). The collaborations with National Taiwan University, Swiss Federal Institute of Technology Zurich and Cardiff University are also performing well, whilst the collaborations with Herriot Watt University and University of Bonn are performing just above the average. Collaborations with Hiroshima are slightly underperforming whereas publications written in collaborations with Universidade de Coimbra, University of Manchester and City University of Hong Kong are performing well below the average.



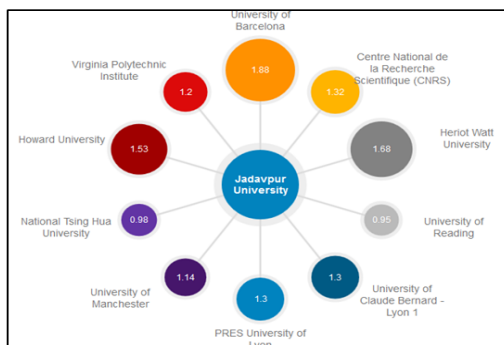
Graph 8: Category Normalized Citation Impact indicator for the top 10 international collaborations of Jadavpur University in 1994-2003.



Graph 9. Jadavpur University top 10 international collaboration in terms of output in 2004-2013

Graph 9 shows the top 10 international collaborations of Jadavpur University in terms of number of papers with other organizations outside of India during 2004-2013. The number of collaborations has grown in comparison to those of 1994-2003. The collaborations with University of Barcelona have now increased from 10 publications in 1994-2003 to 57 publications in 2004-2013. A possible explanation for this is the very good performance of this collaboration in the past. In 2004-2013 Jadavpur University produced the highest number of international collaborations with University of Barcelona (57), followed by CNRS (57) and Herriot Watt University (48). Collaborations with new universities appear in the top 10 from 2004-2013 such as University of Claude Bernard Lyon, Tsing Hua University, Howard University and Virginia Polytechnic Institute.

Graph 10 shows the category normalized performance of the top 10 international collaborations of Jadavpur University during 2004-2013. The increased collaborations with University of Barcelona have paid off as the CNCI impact of these collaborations is 1.88 which means they perform at almost twice the average. The impact of the collaborations with Herriot Watt University (1.68) and University of Manchester (1.14) has also increased. Overall, each of the top 10 international collaborations of Jadavpur University during 2004-2013 performed well. Top performing collaborations can contribute to the increased performance of Jadavpur University, even though it is recommended to assess the full spectrum of the collaboration activities, both national and international, within an organization to understand the full picture.



Graph 10: Category Normalized Citation Impact indicator for the top 10 international collaborations of Jadavpur University in 2004-2013.

4. Conclusions

During the last decade, India has become a leading country in terms of its global share of scientific output. During the period 1980-2014, India's highest percentages of global research output were both in Agricultural Sciences and Chemistry. During 2003-2013, at the institutional level, the largest share of national output was held by University of Delhi, followed by Banaras Hindu University and Jadavpur University. All universities under examination showed an overall steady growth in their field performance during 2004-2014 when compared to 1993-2003; however, it should be noted that whilst the results indicate improvement, the overall field performance of India's selected universities is below the world average; with the exception of Panjab University. The analysis focused on the international collaborations of Jadavpur University to investigate the impact on Jadavpur University's enhanced field performance. The results show that Jadavpur University's top 10 international collaborations during 2004-2014 increased in both output and field performance in comparison to those during 1994-2003. More specifically, Jadavpur University's collaborations characterized by a lower output but high

category normalized citation impact indicator during 1994-2003 continued to increase during 2004-2014 and contributed to a higher institutional performance overall.

References

- AKSNES D.W. and SIVERTSEN G. (2009). A macro-study of scientific of scientific productivity and publication patterns across all scholarly disciplines. 12th International Conference on Scientometrics and Informetrics, 394-398.
- GLANZEL W. and GUPTA B.M. (2008). Science in India: A Bibliometric Study of National Research Performance in 1991-2006. International Society for Scientometrics and Informetrics.
- GUPTA B.M. (2012). Measurement of Indian Science and Technology using publications output data during 1996-2010. Indian Journal of Science and Technology 5 (6), 2899-2905.
- GUPTA B.M. and DHAWAN S.M. (2007). A Scientometric Analysis of S&T Publications Output by India during 1985-2002. DESIDOC Journal of Library & Information Technology 28 (2), 73-85.
- KADEMARI B.S., SAGAR A., KUMAR V. and GUPTA B.M. (2007). Mapping of Indian Publications in S&T: A Scientometric Analysis of Publications in Science Citation Science. DESIDOC Bulletin of Information Technology 27 (1), 17-34.
- MINGERS J. and LIPITAKIS E.A.E.C. (2013). Evaluating a department's research: Testing the Leiden methodology in business and management. Information Processing & Management 49 (3), 587-595.

7. ZHOU P. and LEYDESDORFF L. (2014). The Emergence of China as Leading Nation in Science. Research Policy.
8. InCites available at: <https://incites.thomsonreuters.com> (Accessed 09/02/2015).
9. InCites Indicator Handbook, 2014 available at: <http://ipscience-help.thomsonreuters.com/inCites2Live/indicatorsGroup/aboutHandbook.html> (Accessed 09/02/2015).

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